FISHERY MANAGEMENT INVESTIGATIONS

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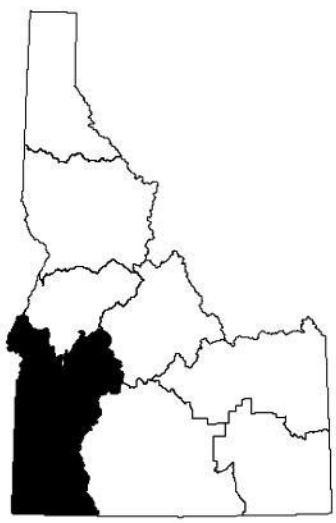

SOUTHWEST REGION
2018

Michael P. Peterson, Regional Fishery Biologist
John D. Cassinelli, Regional Fishery Manager
Joseph R. Kozfkay, State Fishery Manager
Dennis Hardy, Recreation Site Maintenance Foreman

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KOKANEE AND RAINBOW TROUT EVALUATIONS AT ARROWROCK AND LUCKY PEAK RESERVOIRS, IDAHO

ABSTRACT

The kokanee *Oncorhynchus nerka* fisheries at Arrowrock and Lucky Peak reservoirs continue to be two of the most popular in the state and have experienced a sizeable increase in angler interest during the last decade. In 2018, we continued to evaluate these fisheries using a combination of angler creel and gill nets. A total of 343 anglers were creeled with 194 (57%) anglers fishing at Arrowrock Reservoir, and the remaining 149 (43%) having fished at Lucky Peak Reservoir. Anglers at Arrowrock Reservoir were split between trout and kokanee (34% each), while at Lucky Peak Reservoir 46% targeted kokanee. While kokanee catch rates rebounded at Arrowrock in 2018, Lucky Peak catch rates remained low. Additionally, angler catch at both reservoirs was correlated with numerous stocking and environmental factors. At Arrowrock Reservoir, gill net CPUE for age-1 kokanee was 3.2 fish/net-night. Total length of kokanee ranged from 121 to 336 mm with a mean of 276 mm. At Lucky Peak Reservoir, CPUE for age-1 kokanee was 2.5 fish/net-night. Length of kokanee ranged from 110 to 378 mm with a mean length of 245 mm. Age-0 catch was limited in Lucky Peak reservoir and no adipose-clipped age-0 kokanee were captured in 2018. However, recovery of age-1 adipose-clipped kokanee further indicates entrainment from Arrowrock Reservoir remains high and may have been even further exaggerated in 2018 with the above average flows. Due to high angler interest and variability in these fisheries, continued angler effort and population monitoring are important. Ongoing investigations evaluating relationships between stocking or environmental metrics and angler CPUE or growth are an important component of management. Additionally, fall gill netting will continue to provide insight into the following year's fishery.

Author:

John D. Cassinelli
Regional Fishery Biologist

INTRODUCTION

Kokanee salmon *Oncorhynchus nerka* provide recreational fisheries in many waters of the western United States (Foerster 1968; Paragamian 1995; Rieman and Maolie 1995). Kokanee life history differs considerably from other inland salmonids. Kokanee are semelparous salmon that feed and grow in lakes or reservoirs for 2.5 to 3.5 years, then spawn in tributaries or along shorelines during fall before subsequently dying. Eggs incubate in the streambed or shoreline gravels until hatching in late winter. Alevins remain in the gravel for several more weeks before emerging at night and migrating to the lake or reservoir. Fry commonly migrate directly to pelagic areas (Foerster 1968), but can spend time feeding in the littoral habitats, particularly in lakes or reservoirs with pronounced littoral regions (Burgner 1991; Gemperle 1998). Juvenile and adult kokanee are primarily found in pelagic zones of lakes and reservoirs, where they feed almost exclusively on zooplankton.

Managing kokanee fisheries is often challenging and complex because of the wide variation of population responses to system productivity, habitat, predation, and harvest (Paragamian 1995). These responses lead to changes in growth, fecundity, recruitment, age-at-maturity, and survival, which can also vary substantially between year classes. Many kokanee populations exhibit density-dependent growth and this central characteristic of kokanee biology is important for fisheries managers to quantify and understand (Rieman and Myers 1992; Rieman and Maolie 1995; Grover 2006). Many kokanee populations in the western United States exhibit a strong negative relationship between population density and mean body size. Kokanee size and growth not only influence the number and size of fish available to anglers, but also angler's perception of the quality of the fishery (Martinez and Wiltzius 1995; Rieman and Maolie 1995). The tradeoff between density and growth is the key component to kokanee management in most waters and examples of efforts to influence density, growth, and survival are well documented (Rieman and Myers 1992; McGurk 1999)

During the last decade, kokanee have become increasingly popular with anglers in many areas of the western United States. States including Idaho, Oregon, Washington, and California have experienced increased enthusiasm for kokanee fishing. This popularity is reflected in fishing magazine articles, social media, kokanee tournaments, and online forums dedicated to kokanee fishing. Information including stocking histories and regional management reports have become more accessible and easier to distribute to anglers through the World Wide Web. The Idaho Department of Fish and Game (IDFG) has observed a notable increase in angler interest in the management of kokanee fisheries across the state, particularly inquiries into stocking rates.

Arrowrock and Lucky Peak reservoirs are two of the most popular kokanee fisheries in the state and have experienced a sizeable increase in angler interest. Prior to the initiation of annual kokanee stocking in Arrowrock Reservoir, only a marginal fishery existed. This fishery was thought to be supported by kokanee entrained from Anderson Ranch Reservoir with minor recruitment from the Middle Fork Boise, North Fork Boise, and South Fork Boise rivers. The magnitude and variability of these sources of recruitment are not well understood and are likely influenced by inflows, water temperatures, predation, and reservoir levels. IDFG began annual stocking of fingerling kokanee at Arrowrock Reservoir in 2009. Since 2015, the default stocking request for Arrowrock Reservoir has been 100,000 fish or 80 fish/ha stocked in early June (Table 1). This is a two-fold increase in stocking numbers compared to 2012-14.

The kokanee population in Lucky Peak Reservoir relies primarily on annual stocking. However, recent data also shows a high level of entrainment from upstream reservoirs. Although mature kokanee migrate into Mores and Grimes creeks in August, production of wild fry is likely low due to marginal or lethal stream temperatures and poor habitat conditions. IDFG began annual stocking of Lucky Peak Reservoir in 1999. Currently, the default request is 250,000 kokanee fingerlings or 217 fish/ha in early June (Table 1).

Annual variation in angler catch per unit effort (CPUE) at these reservoirs has led IDFG to examine if the cause of this variability may be attributed to size at stocking, timing of stocking, stocking density, or hydrologic conditions. Prior to 2012, IDFG had a sense of which years had produced good fishing, but no actual catch or CPUE data. It is difficult to recommend or implement management changes without data on annual kokanee size or angler CPUE for each year class. Due to the growing popularity of kokanee fishing with anglers, IDFG recognizes the need to monitor these fisheries more quantitatively. Specifically, IDFG should more clearly define kokanee management goals for angler CPUE and size-at-maturity. Additionally, obtaining a better understanding of how reservoir management, spawning conditions, and stocking affect survival and growth of individual year classes should improve IDFG's ability to effectively manage these fisheries. Annual angler CPUE and fish size, primarily CPUE, length-at-age, and length in the creel, will also be used as indices to help describe the effect of stocking practices or reservoir conditions, and will thus help to better understand the potential of the fisheries and angler preferences.

METHODS

Study Areas

Arrowrock Reservoir is a 1,255 ha dendritic impoundment located approximately 32 km northeast of Boise in the Boise River drainage (Figure 1). It is a 29 km-long, narrow canyon reservoir that impounds two major tributaries: the Middle Fork Boise River (MFBR) and South Fork Boise River (SFBR). Arrowrock Dam is located directly upstream of Lucky Peak Reservoir and is operated by the U.S. Bureau of Reclamation (BOR). Arrowrock Reservoir is managed primarily for flood control and irrigation. In a typical year, the reservoir is maintained at approximately 60-80% storage capacity during winter months and generally reaches 100% capacity by May. Beginning in June, the reservoir is drafted, and by August usually reaches 10-35% of capacity (defacto minimum of 50,000 af), after which the reservoir slowly refills during the fall and winter.

Lucky Peak Reservoir is a 1,141-ha mesotrophic impoundment in the Boise River drainage, immediately downstream from Arrowrock Reservoir (Figure 1). It has a mean depth of 32.8 m, a total capacity of 264,000 AF, and is managed by the U.S. Army Corps of Engineers to provide flood control, irrigation, power generation, recreation, and winter flows in the Boise River. In a typical water year, the reservoir is kept at 20-40% of storage capacity during winter and reaches 100% capacity by early summer; subsequently, Arrowrock Reservoir and Anderson Ranch Reservoir releases are utilized to keep Lucky Peak Reservoir near full pool for recreation during the summer months. After Labor Day, Arrowrock begins refilling while Lucky Peak is then drafted to lower pool elevations.

Angler CPUE and fish size

In May 2018, we used check stations to collect creel data and index fisheries metrics. Kokanee creel information has been collected at both Arrowrock and Lucky Peak reservoirs during the month of May since 2012. Data was collected by surveying anglers at a check station, similar to a portion of the access-access survey design described by Pollock et al. (1994). May was selected as an appropriate month because anecdotal observations and angler reports suggest that May is one of the peak months for angling effort directed at kokanee. May also provides the opportunity to directly target and interact with mostly anglers, as recreational boaters do not become a significant portion of reservoir users until after Memorial Day. The focus of creel surveys was on kokanee and Rainbow Trout *Oncorhynchus mykiss,* but data was collected on all fish species encountered.

Creel clerks were stationed at a single site to intercept anglers as they exited the fisheries. The creel station was just east of state Highway 21 at Spring Shores Road turnoff (Figure 1). This creel station intercepted anglers from Spring Shores Marina, and Mack's Creek ramp, and Arrowrock Reservoir. Six dates, with three days of both weekday and weekend/holiday sampling units were randomly selected during May of 2013 and have been used in subsequent years. Two time periods were used: (1) an early time period (0900 - 1500 hours) and (2) a late time period (1500 - 2100 hours).

Data collection focused on completed fishing trips. Each interview or contact was assigned a unique interview number for that day, based on the numerical order by which anglers were contacted. Fishing license numbers, number of anglers in party, time fishing, target species, and the number of each species that were harvested or released were also recorded. Creel clerks were directed to obtain a CPUE per individual angler, although it may be difficult in trolling situations with multiple anglers. Fishing method, gear type, and total length (nearest mm to the tip of the non-pinched tail) and weight (g) of harvested fish were also recorded. Mean angler CPUE ($\widehat{R_2}$) was estimated using the ratio of means (ROM), where trip interviews were considered complete:

$$\widehat{R_2} = \frac{\frac{\sum_{i=1}^{n} c_i}{n}}{\frac{\sum_{i=1}^{n} e_i}{n}}$$

where $\widehat{R_2}$ is the mean CPUE in fish/angler-hour, c_i is the number of fish caught during the trip, and e_i is the length of the trip in hours (equation $\widehat{R_2}$ from Pollock et al. 1994).

All fish sampled from the creel were measured and weighed. Kokanee ages were defined using length-frequency histograms from each reservoir. In previous years, otoliths have been used to confirm age relationships corresponding with length frequencies. Relationships between both age-2 CPUE and length at age-2 and a suite of reservoir and stocking variables (Table 2) were examined by comparing correlation coefficient (*r*), which measures the linear relationship between two variables. These correlations were limited to CPUE of age-2 fish, since that age-class makes up the majority of the total catch and using a specific age allows correlation back to year-specific variables. Variables correlated included the number of fish stocked, stocking date, length at stocking, reservoir inflow and outflow at time of stocking, and reservoir capacity at time of stocking. Additionally, minimum and maximum storage, average storage (during both the lowest three months and lowest month), minimum and maximum inflow and outflow, mean inflow and outflow, and total inflow and outflow; all within the year of stocking and for the year following stocking were also correlated. In previous years, fish caught in Lucky Peak Reservoir were only correlated with Lucky Peak variables. However, given the levels of entrainment of fish from Arrowrock Reservoir into Lucky Peak Reservoir described below, in 2018 we included correlations of fish caught in Lucky Peak Reservoir with Arrowrock Reservoir conditions. The Pearson correlation coefficient (*r)* was calculated as:

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{X_i-\bar{X}}{s_X}\right)\left(\frac{Y_i-\bar{Y}}{s_Y}\right)$$

where X_i *and* Y_i are paired data variables (Zar 1999). Six years classes of stocking (2010 – 2015) were analyzed. As additional years of creel data are collected, these correlations will be further analyzed.

Finally, angler demographics based on license data collected during check station interviews were also analyzed. Angler age, years of license purchase, and address were summarized to gain a better understanding of the clientele using the May fisheries at Lucky Peak and Arrowrock reservoirs.

Gillnetting

Both Lucky Peak and Arrowrock reservoirs were gillnetted in the fall of 2018. Fall netting was implemented as a means to evaluate the kokanee populations post-spawning. Sampling in the fall provides insight into the size of the age class that will spawn the following summer. In other words, age-1+ fish sampled in nets in the fall of 2018 will be the age-2 fish that make up the majority of the fishery the following spring and summer of 2019. Continued fall sampling over time will allow us to develop an index based on CPUE and better predict the numbers of fish available for the following year's kokanee fishery.

Gillnetting was conducted at Lucky Peak Reservoir on the evening of October 11th, 2018 and at Arrowrock Reservoir on October 10th, 2018. In each water, two gill nets were used to sample the entire kokanee layer at three locations, for a total of six net-nights. Nets were set at dusk and retrieval started at dawn of the following day. Each gill net measured 48.8 m in length and 6.0 m in depth. Gill nets contained 16 panels, each measuring 3.0 m in length. Nets consisted of eight different mesh sizes (13, 19, 25, 38, 51, 64, 76, 102 mm; stretch measure) with two panels of each mesh size randomly positioned throughout the net. Each pair of gill nets were horizontally suspended with the two nets covering 2 to 14 m of water depth. Sampled fish were measured for total length (mm) and weighed (g) and otoliths were removed.

Otoliths were processed to identify thermal marks applied to hatchery-origin fish at Cabinet Gorge Hatchery. These unique thermal marks allow for both identifying and aging of hatchery kokanee. All kokanee produced at Cabinet Gorge Hatchery are thermally marked. Therefore, any kokanee lacking a thermal mark were presumed to be from natural production. Kokanee stocked into both reservoirs in 2017 were thermally marked, while those stocked in 2018 were obtained from the state of Washington and had not received a thermal mark.

In an effort to quantify the amount of entrainment that occurs between Arrowrock and Lucky Peak reservoirs, 20% of the 100,000 kokanee (≈ 20,000) fingerlings stocked into Arrowrock Reservoir were marked with an adipose fin clip in both 2017 and 2018. These fish were hand-clipped by Region 3 staff at the Mackay Fish Hatchery in late April of each year. All kokanee captured in gill nets at both Lucky Peak and Arrowrock reservoirs were examined for a fin clip. At Lucky Peak Reservoir, the number of recovered adipose-clipped kokanee was expanded by the year-specific clipping rate. Then, the unclipped (Lucky Peak Reservoir-origin) fish recovered by age were divided by the total number of Lucky Peak fingerlings stocked for that specific year class, to get a capture percentage. The expanded Arrowrock fish (from the same age-class) were then divided by this same percentage to generate an estimated total number of Arrowrock-stocked fish entrained in Lucky Peak Reservoir, by age.

RESULTS

Angler CPUE and Fish Size

A total of 343 anglers were interviewed in May of 2018. Of the 343 anglers interviewed, 194 (57%) anglers had fished at Arrowrock Reservoir, and the remaining 149 (43%) anglers had fished at Lucky Peak Reservoir (Table 3). Average trip duration of anglers fishing at Arrowrock and Lucky Peak reservoirs were 4.5 and 3.6 h, respectively. Only 39% of the interviewed anglers reported their primary target species as kokanee in 2018 (34% at Arrowrock Reservoir; 46% at Lucky Peak Reservoir). Approximately 34% of the anglers at Arrowrock Reservoir and 26% at Lucky Peak Reservoir indicated they were targeting Rainbow Trout (Figure 2). Anglers indicating they had no preference of fish species represented 27% and 26% of anglers at Arrowrock and Lucky Peak reservoirs, respectively. Finally, 3% of Arrowrock Reservoir anglers and 6% of Lucky Peak Anglers targeted Smallmouth Bass.

Contrary to 2017, anglers fishing Arrowrock Reservoir had higher kokanee catch rates than angles fishing Lucky Peak Reservoir. Lucky Peak Reservoir had low catch rates compared to previous years with only 20 total kokanee checked during the entire survey. On average, anglers targeting kokanee harvested 2.1 kokanee at Arrowrock Reservoir and 0.3 kokanee at Lucky Peak Reservoir, per trip. At Arrowrock Reservoir, approximately 29% of kokanee anglers were unable to harvest a kokanee during that specific trip, while 80% of anglers did not harvest a kokanee at Lucky Peak Reservoir (Figure 3). While none of the interviewed kokanee anglers harvested their bag limit at Lucky Peak Reservoir, 16% of the kokanee anglers fishing Arrowrock Reservoir harvested their bag limit. At Arrowrock Reservoir, overall CPUE of kokanee was 0.16 fish/h, while CPUE at Lucky Peak Reservoir was 0.04 fish/h (Table 4). For anglers targeting kokanee, CPUE was somewhat higher, with 0.32 fish/h estimated at Arrowrock Reservoir and 0.06 fish/h at Lucky Peak Reservoir. Length of kokanee in the creel from Arrowrock Reservoir ranged from 310 to 460 mm, with a mean of 408 mm (Figure 4). At Lucky Peak Reservoir, fish ranged from 375 to 440 mm, with a mean of 414 mm (Figure 4).

Anglers targeting Rainbow Trout harvested an average of 0.2 Rainbow Trout at Arrowrock Reservoir and 0.5 Rainbow Trout at Lucky Peak Reservoir. Approximately 71% and 69% of Rainbow Trout anglers were unsuccessful in harvesting Rainbow Trout at Arrowrock and Lucky Peak reservoirs, respectively. No interviewed anglers harvested a limit of Rainbow Trout (six fish) at either reservoir (Figure 3). Rainbow Trout were caught at overall rates of 0.15 and 0.11 fish/h at Arrowrock and Lucky Peak reservoirs, respectively (Table 4). Angler CPUE for anglers specifically targeting Rainbow Trout was 0.07 fish/h at Arrowrock Reservoir and 0.17 fish/h at Lucky Peak Reservoir. Rainbow Trout at Arrowrock Reservoir ranged from 290 to 440 mm with a mean of 356 mm, while fish from Lucky Peak Reservoir ranged from 260 to 475 mm with a mean of 329 mm (Figure 5).

At Lucky Peak Reservoir, angler CPUE of age-2 kokanee continued to be positively correlated with later stocking and increased minimum inflow during the fish's stocking year and second year in the reservoir (Table 2). The length of kokanee at age-2 is most correlated with the minimum and maximum inflow and maximum outflow in the fish's second year in the reservoir as well as maximum storage during stocking year. Both age-2 CPUE and length at age-2 are negatively correlated with the number of fish stocked (Table 2). When correlated with conditions in Arrowrock Reservoir, Lucky Peak age-2 kokanee catch is strongly related to increased minimum storage the year of stocking as well as increased inflow and outflow the year of stocking and increased inflow at the time of stocking.

Based on knowledge of the overall fishing season at Arrowrock Reservoir in 2015, the high angler CPUE observed there for that year was likely an outlier. Our CPUE calculations were likely biased high by a short period of good fishing that corresponded with the creel period, and this value was not representative of the Arrowrock fishery as a whole. Therefore, the 2015 CPUE was removed from our correlation analysis. At Arrowrock Reservoir there were strong positive correlations between angler CPUE at age-2 and numerous flow metrics including inflow at time of stocking; as well as maximum, mean, and total inflow and outflow during the year of stocking. (Table 2). There was a strong negative correlation between both CPUE and fish length and minimum inflow the fish's second year in the reservoir.

Median age of anglers targeting kokanee in Lucky Peak and Arrowrock reservoirs was 49 years old. Ages ranged from 14 to 90 years old (excluding children under the age of 12). The majority were male (95%) and Idaho residents (97%). Of the Idaho residents, 91% reside in either Ada or Canyon counties. Trout anglers averaged 44 years old and ranged from 15 to 86 (again, excluding those anglers under 12). Similar to kokanee anglers, the majority were male (75%) and Idaho residents (99%) residing in Ada and Canyon counties (91%). When we ignored target species and looked at all 322 anglers, they were 81% male, 98% residents, and the average age was 47 (range 14-90).

Gillnetting

At Arrowrock Reservoir, gill nets captured a total of 19 kokanee. Other fish encountered included Rainbow Trout, Yellow Perch *Perca flavescens*, Largescale Sucker *Catostomus macrocheilus*, Chiselmouth *Acrocheilus alutaceus*, Redside Shiner *Richardsonius balteatus*, and Northern Pikeminnow *Ptychocheilus oregonensis*. Gill net CPUE for kokanee was 3.2 fish/net-night for age-1 fish. No age-0 fish were captured. Length of kokanee ranged from 121 to 336 mm with a mean of 276 mm (Figure 6). Of the 19 kokanee sampled, otoliths from 18 were successfully determined to be of hatchery origin. Of these 18, 2 (11%) were hatchery origin age-0 and the remaining 16 (89%) were hatchery-origin age-1.

At Lucky Peak Reservoir, a total of 23 kokanee and 12 fall Chinook Salmon *Oncorhynchus tshawytscha* were captured in gill nets. Rainbow Trout, Yellow Perch, Largescale Sucker, Chiselmouth, Redside Shiner, and Northern Pikeminnow were also captured. Gill net CPUE was 1.3 fish/net-night for age-0 and 2.5 fish/net-night for age-1 kokanee. Length of kokanee ranged from 110 to 378 mm with a mean length of 245 mm (Figure 6). Of the 23 kokanee sampled, otoliths from 20 were successfully processed to evaluate thermal marking. Of these 20 samples, 15 were determined to be of hatchery origin. Three samples (15%) were hatchery origin age-0, 12 (60%) were hatchery origin age-1, and 5 (25%) had no discernable thermal mark and were presumed to be natural origin. The lengths of the 5 natural origin fish indicated three were age-0 and 2 were age-1 (Table 5).

Estimates of age-1 kokanee entrainment from Arrowrock Reservoir into Lucky Peak Reservoir continue to be highly variable. This is most likely due to the small number of kokanee that have been captured in Lucky Peak Reservoir in 2017 and 2018. In 2018, only three hatchery origin age-0 kokanee were sampled in gill nets and none were adipose-clipped. Three out of 12 hatchery origin age-1 kokanee were adipose clipped in 2018, following four out of 20 of that year class being clipped when they were sampled in 2017 as age-0.

DISCUSSION

Angler CPUE and Fish Size

While kokanee catch rates continued to decline in Lucky Peak Reservoir, Arrowrock Reservoir provided a decent fishery in 2018 with the highest catch rates observed there since 2015 (Figure 7). The continued low catch rates in Lucky Peak Reservoir are most likely a carryover from the high flows experienced in 2017. In addition to low catch rates, Lucky Peak Reservoir also experienced the lowest amount of kokanee angler effort we've observed across the seven years of our creel surveys. This coincided with an upswing in effort at Arrowrock Reservoir, while continued high catch rates at Anderson Ranch Reservoir have also likely further dispersed kokanee anglers. No interviewed anglers from Lucky Peak Reservoir caught a limit of kokanee in 2018 and very few anglers harvested more than two kokanee. Conversely, the percentage of anglers who were unable to harvest a kokanee at Lucky Peak Reservoir was 80% (Compared to 81% in 2017, 45% in 2016 and 82% in 2015. However, at Arrowrock Reservoir 16% of kokanee anglers were able to catch their daily bag limit and the percentage of anglers that were unable to harvest a kokanee was down to 29% after being 92% in 2017 (82% in 2016 and 30% in 2015). For the first time in the seven years of the survey, Lucky Peak Reservoir produced larger average sized kokanee than Arrowrock Reservoir (Figure 7), though very few kokanee were caught in Lucky Peak. As observed over the course of these surveys, these metrics continue to confirm the variable nature of these fisheries. The downward trend in kokanee fishing at Lucky Peak Reservoir is likely due to a combination of water supply and reservoir management (high flush through in 2017), slight shifts in stocking practices (earlier stocking), fingerling size at stocking (smaller fingerlings), and variable entrainment levels from both Arrowrock Reservoir into Lucky Peak Reservoir and from Lucky Peak Reservoir into the lower Boise River.

Angler CPUE of Rainbow Trout amongst those anglers targeting trout was down at both Lucky Peak and Arrowrock reservoirs, while it was slightly up from 2017 for those anglers targeting kokanee (Figure 8). Lucky Peak Reservoir had slightly higher CPUE than Arrowrock Reservoir, but angler effort at Arrowrock Reservoir was the second highest it has been since 2012 (Figure 8). The average length of Rainbow Trout in the creel was also the second highest observed at Arrowrock Reservoir since 2012 and there continues to be a general increasing average length of Rainbow Trout caught in both reservoirs since 2014 (Figure 8). This increasing size trend corresponds with the change in catchable stocking size from a 10-inch average to a 12-inch average. Additionally, Rainbow Trout from Arrowrock Reservoir continued to be longer than Rainbow Trout from Lucky Peak Reservoir. This difference has averaged 1.0 inch across all seven years of the creel surveys and was 1.1 inches in 2018.

Prior to 2017, Rainbow Trout anglers represented about 25% of all anglers interviewed. However, in 2017, Rainbow Trout anglers represented 42% of all anglers. The proportion of Rainbow Trout anglers dropped off again in 2018 as they represented 31% of all anglers while kokanee anglers represented 40%. Kokanee effort and success is highly variable from year to year given their short life cycle and variable growth and survival. However, Rainbow Trout fisheries have remained much more consistent from year to year in both reservoirs.

We continue to analyze correlations between both stocking and environmental rearing conditions and age-2 size and catch rates of kokanee in both Lucky Peak and Arrowrock reservoirs. With each added year of data, relationships change and some are strengthened while others are weakened. With the addition of the 2018 data, there were few strong correlations between stocking and environmental conditions and CPUE at Lucky Peak. Later stocking time and increased inflow and outflow in the year of stocking all correlated with higher catch at age-2 in Lucky Peak Reservoir. There were an increased number of correlations in Arrowrock Reservoir where higher catch was correlated with numerous flow metrics. Additionally, 2018 was the first year we examined correlations between Arrowrock Reservoir conditions and CPUE in Lucky Peak. With the high rates of entrainment that we have observed, this seemed like a logical analysis and there were numerous correlations. In fact, CPUE in Lucky Peak Reservoir was more highly correlated with flow and storage conditions in Arrowrock Reservoir than it was with conditions in Lucky Peak Reservoir (Table LP2). Higher minimum storage along with higher inflow and outflow in the year fish are stocked in Arrowrock all were highly correlated with subsequent increased catch of those same fish as age-2 in Lucky Peak Reservoir. It appears that more water moving through Arrowrock Reservoir is beneficial to eventual catch in both reservoirs. How these factors are influencing catch in both waters needs further investigation. These relationships at both reservoirs continue to fluctuate with the addition of stocking years to the dataset, but are more and more telling as the dataset and sample sizes increase. Observed relationships are likely to continue to fluctuate from year to year as the dataset grows and it may take some time for us to understand what factors are having the greatest impacts on length and CPUE of age-2 kokanee in both Lucky Peak and Arrowrock reservoirs.

Gillnetting

Klein et al. (2019) found that using overnight experimental curtain gill net sets, suspended in the kokanee layer of the water column, was the most effective tool to capture and monitor kokanee populations in Arrowrock and Lucky Peak reservoirs. Starting in 2017, gill nets have been used as the primary tool for annually sampling these populations in both reservoirs. In both 2017 and 2018, gill net samples from both reservoirs provided low numbers of kokanee and few age-0 sized fish. As gill net indices are established over the next several years, it will be important for us to gain a better understanding of an appropriate number of nets to adequately sample the population and provide an appropriate estimate of age-specific populations each fall.

Low capture rates of age-0 kokanee in Lucky Peak Reservoir made it difficult to assess entrainment from Arrowrock for fish stocked in 2018. However, age-1 adipose clipped kokanee were recovered at a similar rate to the age-0 recoveries in 2017, further confirming that the majority of the kokanee in Lucky Peak from 2017 stocking, entrained from Arrowrock. This followed an estimated 60-75% from the 2016 stocking year. We are now able to track age-specific entrainment of both age-0 and age-1 kokanee based on otolith thermal marks. We will continue to adipose clip at least 20% of the kokanee being stocked into Arrowrock Reservoir to further monitor entrainment and gain a better understanding of its variability through time.

2018 was the second consecutive year of using thermally-marked otoliths to identify hatchery and natural-origin kokanee recovered from gillnets in both reservoirs. In 2017, 23% of the age-1 kokanee from Lucky Peak and 49% of the age-1 kokanee from Arrowrock were of natural origin. In 2018, the Lucky Peak proportion of natural origin age-1 fish was down to 10% and no natural origin age-1 fish were sampled in Arrowrock Reservoir. Age-1 natural origin fish would have spawned in the fall of 2016 and emerged in the spring of 2017. Fraley et at. (1986) found that kokanee emerged from mid-March through mid-May in McDonald Creek, MT. Spring flows in the Boise Basin in 2017 were exceptionally high. By April 1st of 2017, the upper South Fork Boise River above Anderson Ranch and the Middle Fork Boise River above Arrowrock experienced flows over 400% of average, while Mores Creek experienced flows over 360% of average. These high flows could have had a negative impact on wild kokanee survival. Given the previously described findings of high rates of entrainment between reservoirs, natural origin kokanee recovered in Lucky Peak and Arrowrock reservoirs could be from a variety of source populations throughout the Boise River Basin. Additionally, the high proportion of natural origin kokanee observed in both waters in 2017 might be elevated given the overall low numbers of age-1 hatchery origin fish present.

The kokanee fisheries in Lucky Peak and Arrowrock reservoirs are highly popular. These two large Boise River Basin reservoirs (along with Anderson Ranch Reservoir in the Magic Valley Region) produce a high level of regional angling effort annually and the demand for these fisheries continues to increase. Recent trends in decreased catch rates at Lucky Peak along with inconsistent fisheries in Arrowrock are concerning. Continued monitoring of angler catch and effort, environmental variability, population trends, entrainment, and hatchery/natural composition have emphasized the complexity of this system. Continued data collection will help managers further understand these relationships and improve the management of these complex, highly popular sport fisheries.

RECOMMENDATIONS

1. Continue to monitor kokanee stocking practices and the effect of environmental conditions at Arrowrock and Lucky Peak reservoirs by indexing CPUE using annual check stations during May.
2. Continue using curtain gill nets to evaluate kokanee relative abundance through annual index surveys.
3. Continue to adipose fin clip a portion of the hatchery-origin kokanee to be stocked in Arrowrock Reservoir to monitor entrainment into Lucky Peak Reservoir.

Table 1. Kokanee stocking dates and associated fish densities, mean total length (mm), and mean weight (fish/lb) at stocking for Arrowrock and Lucky Peak reservoirs, Idaho between 2004 and 2018.

Waterbody	Year	Date	No. Fish	Mean size (mm)	Fish/lb	Stocking density (fish/ha)	Stocking density (lb/ha)
Arrowrock	2004	14-Jun	77,025	100.0	41.1	61	1.5
Reservoir	2006	9-May	70,000	89	79.1	56	0.7
1,255 ha	2010	3-Jun	29,000	79	116.0	23	0.2
	2011	8-Jun	30,000	76	100.0	24	0.2
	2012	2-May	50,130	76	111.4	40	0.4
	2013	1-May	50,160	69	152.0	40	0.3
	2014	15-May	49,995	76	97.1	40	0.4
	2015	13-May	101,198	81	95.7	81	0.8
	2016	4-May	99,992	81	100.9	80	0.8
	2017	7-Jun	103,579	84	92.0	83	0.9
	2018	5-Jun	98,580	69	164.0	79	0.7
Lucky Peak	2004	14-Jun	155,950	90	108.4	135	1.2
Reservoir	2005	3-Jun	200,150	86	75.5	174	2.3
1,153 ha	2006	24-May	308,050	83	101.0	267	2.6
	2007	31-May	245,000	89	87.5	212	2.4
	2008	3-Jun	195,570	57	288.4	170	0.6
	2009	3-Jun	199,800	83	99.9	173	1.7
	2010	3-Jun	151,050	79	100.7	131	1.3
	2011	8-Jun	174,640	76	94.4	151	1.6
	2012	2-May	200,910	76	107.9	174	1.6
	2013	1-May	251,877	69	148.6	218	1.5
	2014	15-May	237,120	76	98.8	206	2.1
	2015	13-May	250,515	81	87.9	217	2.5
	2016	4-May	252,993	81	99.8	219	2.2
	2017	18-Apr	99,998	49	478.0	87	0.2
	2017	7-Jun	194,220	78	117.0	168	1.4
	2018	5-Jun	214,310	71	148.0	219	2.2

Table 2. Relationship of kokanee length and angler CPUE at age-2 expressed as correlation coefficient (r) values for a suite of reservoir and stocking metrics at both Lucky Peak (vs. fish caught at Lucky Peak) and Arrowrock (vs. fish caught in either Arrowrock or Lucky Peak) reservoirs. Data is from stocking years 2010 through 2016.

Metric	Lucky Peak to Lucky Peak		Arrowrock to Arrowrock		Arrowrock to Lucky Peak	
	CPUE	Length	CPUE	Length	CPUE	Length
Number of fish stocked	-0.923	-0.296	-0.379	-0.504	-0.932	0.034
Stock-day post May 1	0.731	0.262	0.269	0.013	0.731	0.262
Length (mm) at stocking	0.002	0.324	-0.393	-0.444	-0.148	0.299
Total inflow (cfs) at time of stocking	0.215	-0.103	0.909	0.586	0.728	0.358
Total outflow (cfs) at time of stocking	0.322	-0.073	0.583	0.513	0.130	-0.144
Percent capacity at time of stocking	0.007	0.435	-0.337	-0.255	-0.548	-0.085
Minimum storage (acre-feet), stocking year	0.029	-0.514	0.401	0.214	0.792	0.382
Minimum storage (acre-feet), year following stocking	0.016	-0.064	0.22	0.138	-0.042	0.884
Maximum storage (acre-feet), stocking year	-0.056	0.702	-0.511	-0.352	-0.057	0.429
Maximum storage (acre-feet), year following stocking	-0.182	-0.095	-0.157	-0.255	-0.289	0.123
Ave storage (acre-feet), lowest three months of stocking year	0.078	-0.595	0.604	0.37	0.914	0.302
Ave storage (acre-feet), lowest three months of year following stocking	0.247	-0.060	0.395	0.259	0.128	0.854
Ave storage (acre-feet), lowest single month of stocking year	0.020	-0.632	0.694	0.433	0.898	0.214
Ave storage (acre-feet), lowest single month of year following stocking	0.139	-0.039	0.425	0.250	0.233	0.860
Minimum inflow (cfs), stocking year	0.662	0.107	-0.24	-0.283	-0.699	-0.316
Maximum inflow (cfs), stocking year	0.689	0.152	0.728	0.613	0.724	0.184
Mean inflow (cfs), stocking year	0.536	0.251	0.853	0.588	0.507	0.253
Minimum outflow (cfs), stocking year	-0.453	-0.052	a	a	a	a
Maximum outflow (cfs), stocking year	0.573	0.460	0.796	0.695	0.759	0.246
Mean outflow (cfs), stocking year	0.526	0.255	0.834	0.585	0.506	0.249
Total inflow (cfs), stocking year	0.506	0.220	0.834	0.524	0.473	0.217
Total outflow (cfs), stocking year	0.495	0.222	0.815	0.522	0.473	0.215
Minimum inflow (cfs), year following stocking	-0.203	0.830	-0.945	-0.693	-0.597	-0.308
Maximum inflow (cfs), year following stocking	0.141	0.758	0.699	0.368	0.184	0.710
Mean inflow (cfs), year following stocking	0.208	0.593	0.439	0.198	-0.198	0.769
Minimum outflow (cfs), year following stocking	-0.583	0.117	a	a	a	a
Maximum outflow (cfs), year following stocking	-0.029	0.683	0.564	0.327	-0.170	0.778
Mean outflow (cfs), year following stocking	0.219	0.588	0.454	0.21	-0.179	0.756
Total inflow (cfs), year following stocking	0.207	0.621	0.419	0.184	-0.205	0.786
Total outflow (cfs), year following stocking	0.200	0.623	0.434	0.197	-0.187	0.772

Table 3. Creel survey sampling schedule dates, day type, time period, and number of anglers interviewed during each sampling period for creel check stations at Arrowrock and Lucky Peak reservoirs in May, 2018. Dates, day type, and time period were initially selected randomly in 2012.

Date	Day type	Time period	Arrowrock	Lucky Peak
4/30	Weekday	Late	8	2
5/6	Weekend/Hol	Early	43	47
5/19	Weekday	Early	11	25
5/18	Weekday	Early	36	10
5/25	Weekend/Hol	Late	28	18
5/27	Weekend/Hol	Late	68	47
Total			194	149

Table 4. Angler CPUE by time periods, day type, angling methods, and gear types for kokanee and Rainbow Trout at Arrowrock and Lucky Peak reservoirs, Idaho in 2018.

	Kokanee (fish/h)		Rainbow Trout (fish/h)	
	Arrowrock	Lucky Peak	Arrowrock	Lucky Peak
Weekday	0.27	0.06	0.18	0.20
Weekend/Hol	0.05	0.03	0.11	0.06
Early period	0.16	0.05	0.13	0.15
Late period	0.17	0.02	0.15	0.03
Kokanee targeted	0.32	0.06	0.20	0.13
Rainbow Trout targeted	0.02	0.00	0.07	0.17
Overall	0.16	0.04	0.15	0.11

Table 5. Age and origin of 2018 gill net sampled kokanee from Lucky Peak and Arrowrock reservoirs as determined by otolith thermal marks.

Water		Hatchery origin		Natural origin	
		Age-0	Age-1	Age-0	Age-1
Lucky Peak	Number	3	12	3	2
	Percent	15%	60%	15%	10%
	Mean TL (mm)	141	322	134	299
Arrowrock	Number	2	16	0	0
	Percent	11%	89%	0	0
	Mean TL (mm)	123	294	/	/

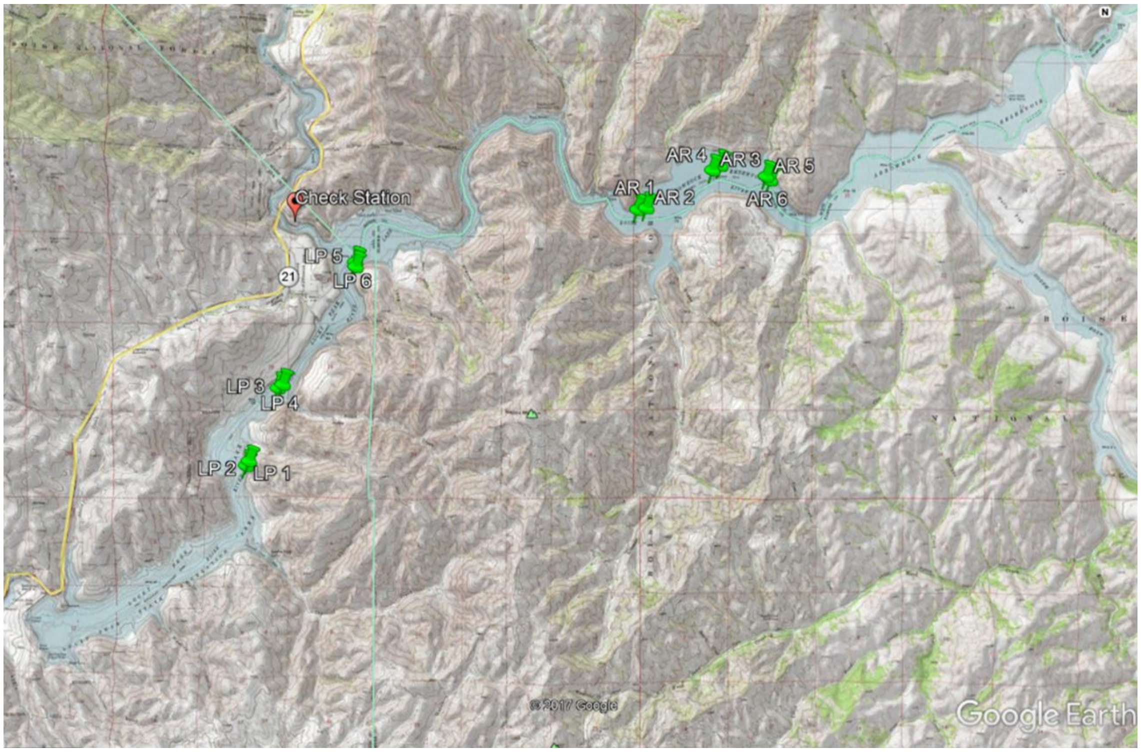


Figure 1. Map of Arrowrock and Lucky Peak reservoir, Idaho, with location of the creel check station where clerks can intercept anglers from both waters and six trend gillnet sights on each reservoir.

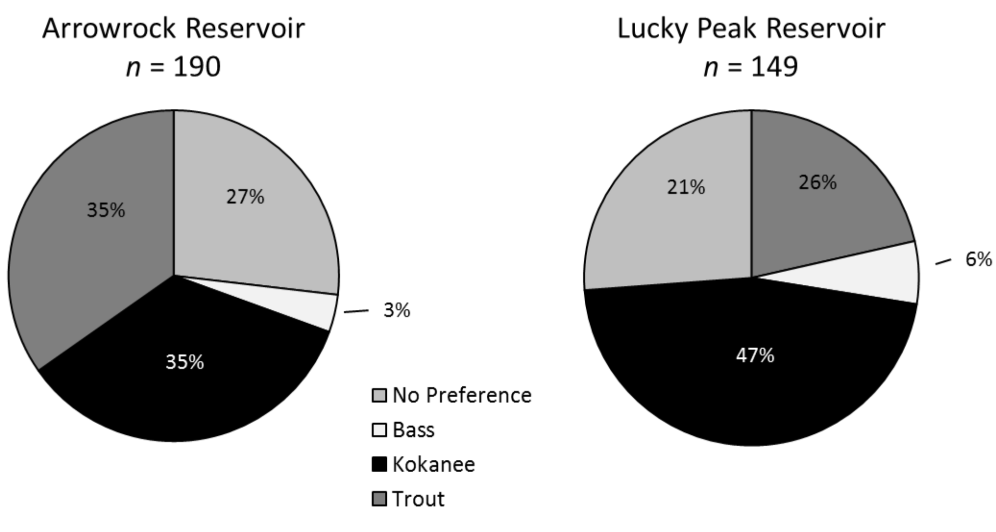


Figure 2. Proportion of anglers targeting game fish species at Arrowrock and Lucky Peak reservoirs in May 2018.

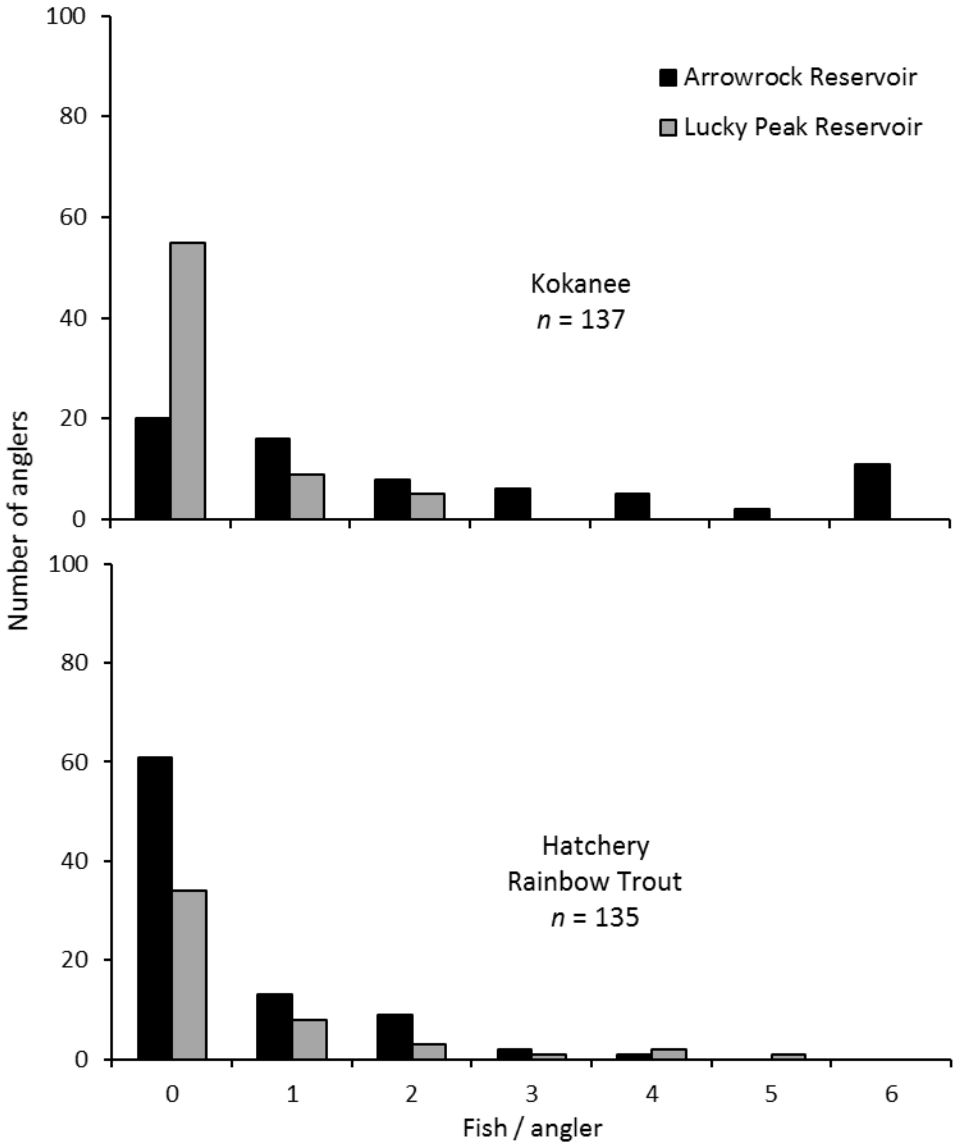


Figure 3. Frequency of harvest by angler for kokanee and Rainbow Trout at Arrowrock and Lucky Peak reservoirs in 2018.

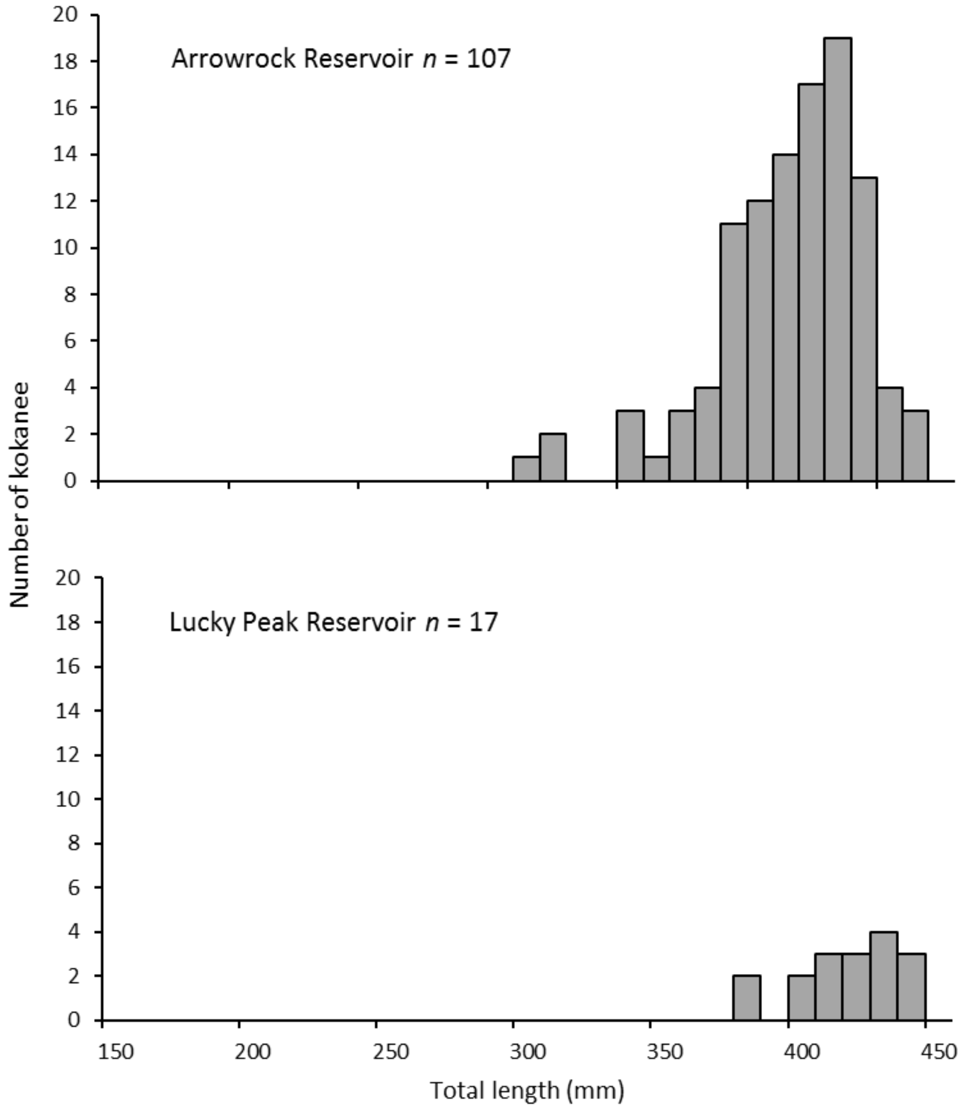


Figure 4. Length-frequency distributions of kokanee observed in the creel in May 2018 at Arrowrock and Lucky Peak reservoirs.

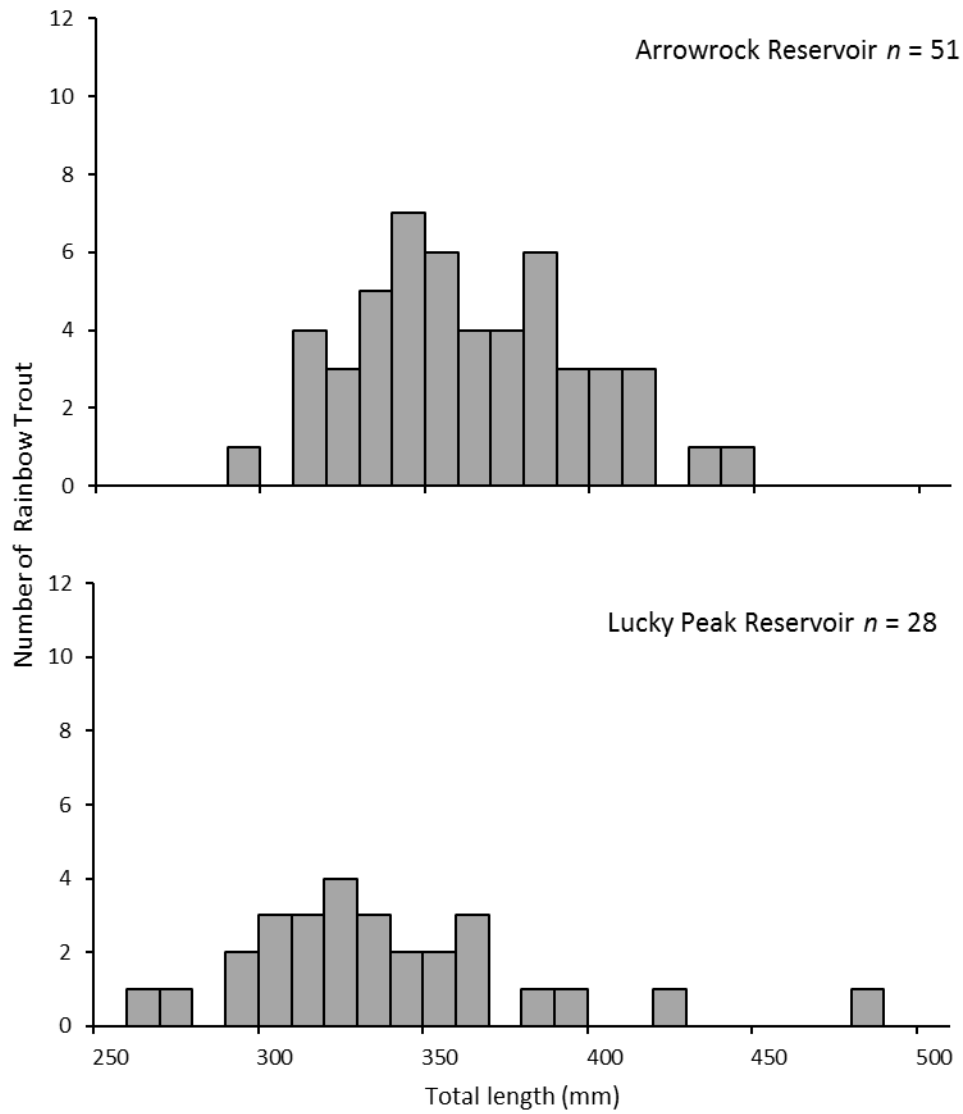


Figure 5. Length-frequency distributions of Rainbow Trout observed in the creel in May 2018 at Arrowrock and Lucky Peak reservoirs.

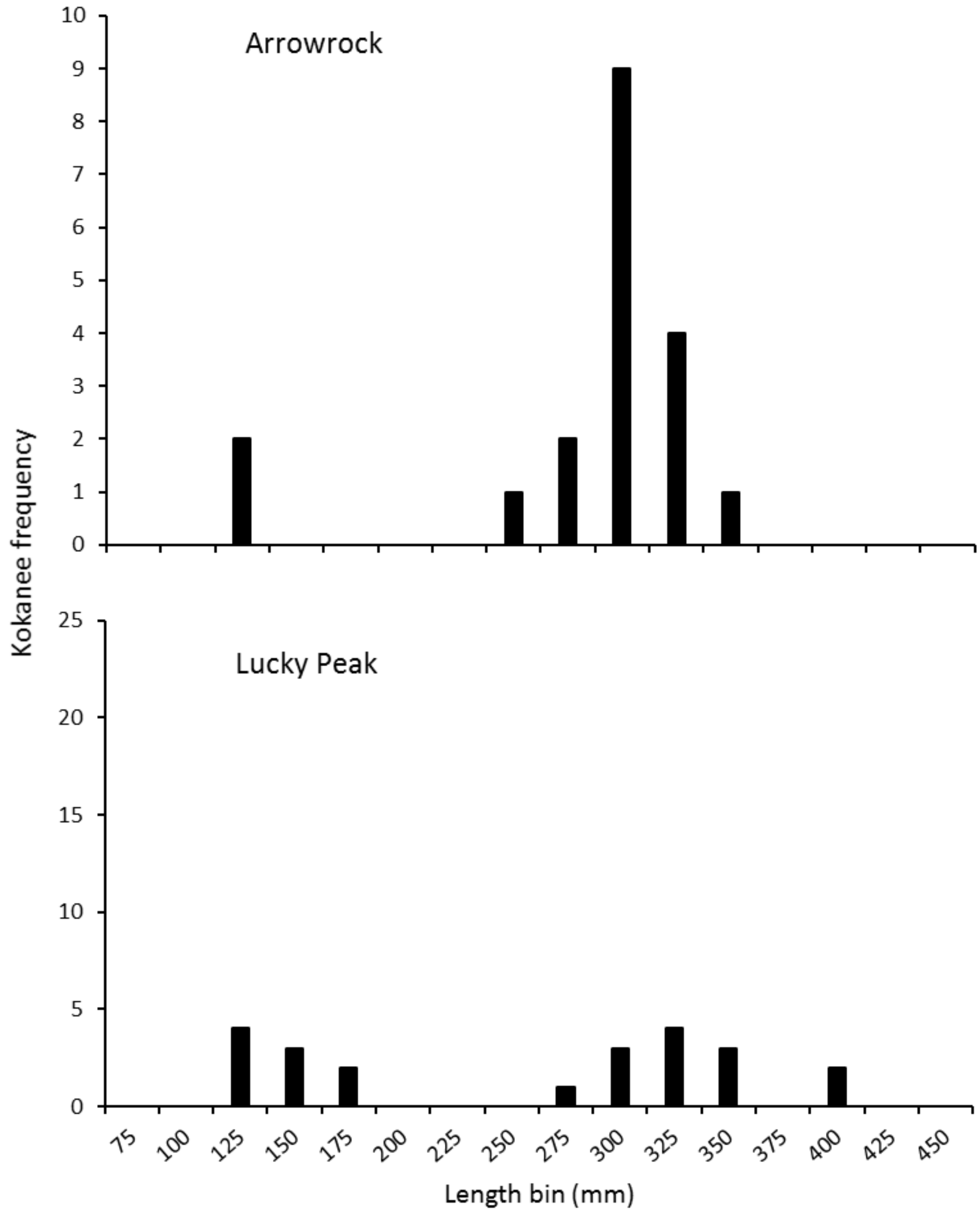


Figure 6. Length-frequency distributions of kokanee captured in gill nets in the fall of 2018 at Arrowrock and Lucky Peak reservoirs.

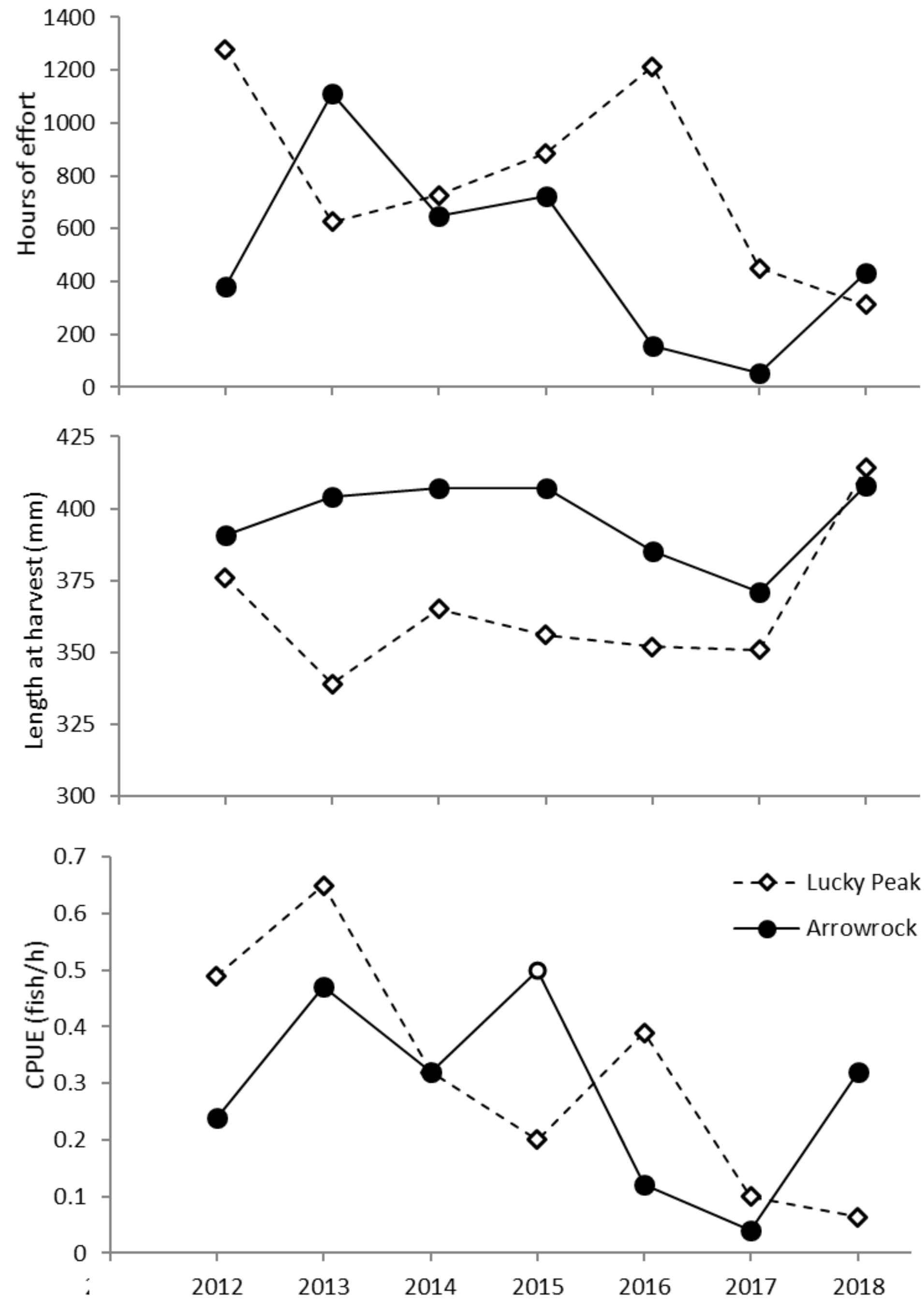


Figure 7. Trends in kokanee hours fished, kokanee mean length in creel (mm), and kokanee CPUE (fish/h) at Arrowrock and Lucky Peak reservoirs during May 2012 to 2018. CPUE data at Arrowrock in 2015 is likely biased high and considered an outlier based on other anecdotal evidence.

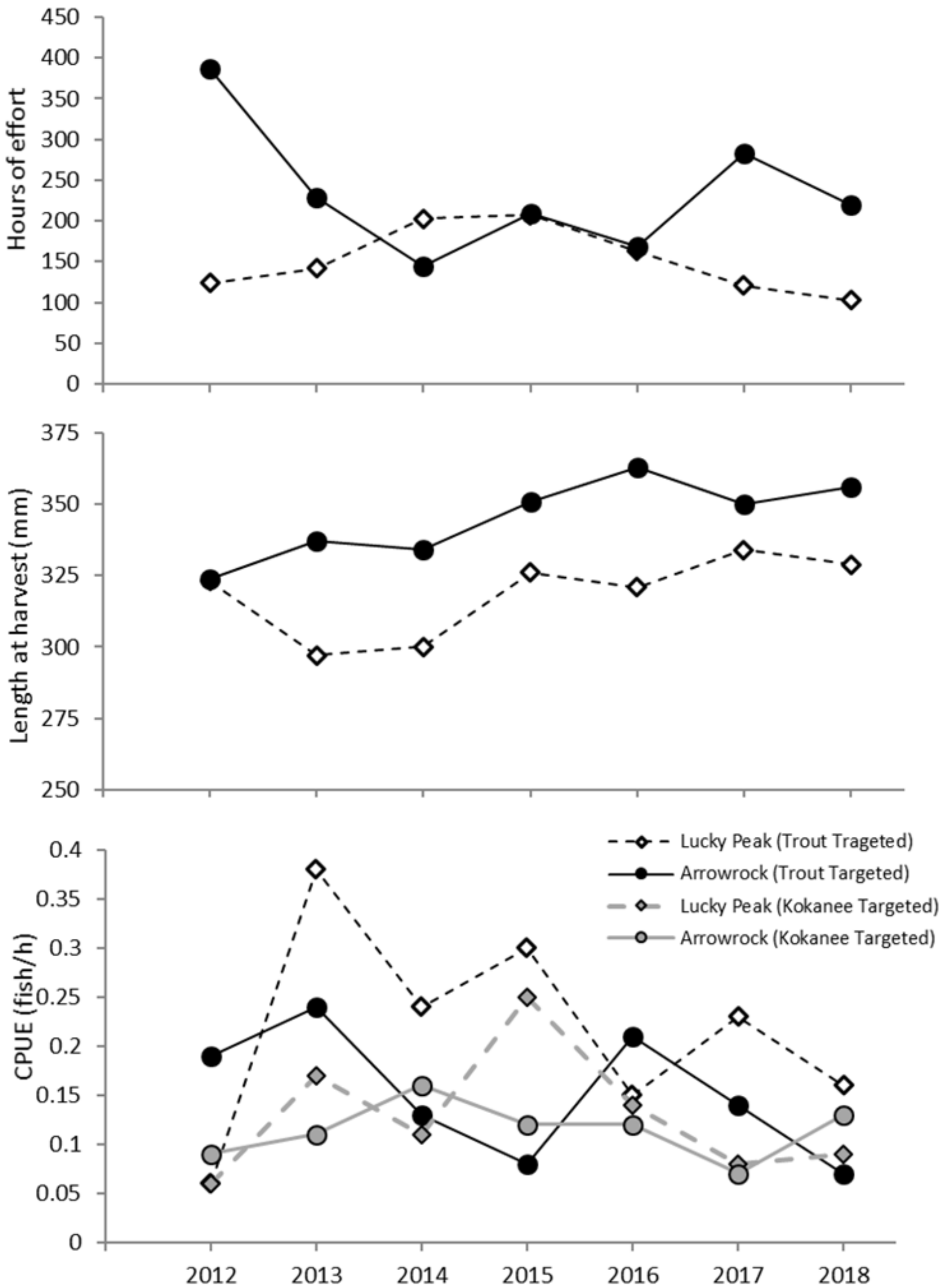


Figure 8. Trends in trout anglers interviewed, hours fished, Rainbow Trout mean length in creel (mm), and Rainbow Trout CPUE (fish/h) at Arrowrock and Lucky Peak reservoirs during May 2012 to 2017. Data in the top two graphs is for anglers specifically targeting Rainbow Trout, while the bottom graph shows Rainbow Trout catch for angler targeting either trout of kokanee.

DEADWOOD RESERVOIR MONITORING

ABSTRACT

Kokanee salmon *Oncorhynchus nerka* provide recreational fisheries and a prey base for piscivores in many waters of the western United States. The fishery at Deadwood Reservoir is supported primarily by kokanee and other salmonids that may prey on kokanee to reach large sizes. Additionally, this kokanee population has historically been Idaho’s primary egg source to produce hatchery kokanee of early run strain. Kokanee escapement has been managed annually since 2010 to regulate fish densities and meet egg collection goals for hatchery stocking of other kokanee fisheries, while still providing desirable sizes for the sport fishery. Gill netting is important for setting escapement targets and monitoring the effectiveness of management strategies. In 2018, kokanee gill net CPUE was 27.7 fish/net-night. Additionally, a month-long creel survey was conducted to evaluate angler harvest impacts on the kokanee population in regards to spawners available for egg take. In the 2018 ten-week kokanee fishery, anglers harvested over 26,000 adult kokanee while only 20,000 adults subsequently returned to the Deadwood River to spawn. Given the significant impact of angler take on the kokanee population, IDFG suggested reducing the daily bag limit from 25 to 15 fish/day. This rule change was adopted by the IDFG commission and will take effect in 2019.

Author:

John D. Cassinelli
Regional Fishery Biologist

INTRODUCTION

Deadwood Reservoir is a 1,260-ha impoundment located on the Deadwood River in Valley County, approximately 40 km southeast of Cascade, Idaho and 85 km northeast of Boise, Idaho. Completed in 1931, the reservoir offers a scenic setting at a relatively high elevation (1,615m above sea level), and is a popular destination during summer. Deadwood Reservoir offers abundant sport fishing opportunities for kokanee *Oncorhynchus nerka,* resident fall Chinook Salmon *O. tshawytscha*, Rainbow Trout *O. mykiss,* and Westslope Cutthroat Trout *O. clarki lewisi*. Bull Trout *Salvelinus confluentus* are present, but at a very low abundance.

Deadwood Reservoir's kokanee population serves as Idaho's primary egg source for producing hatchery-reared early spawning kokanee. Historically, this population has provided up to 7 million eggs to IDFG hatcheries annually. Resultant fry and fingerlings have been distributed to 15-20 waters statewide. However, because their life cycle is so short, kokanee populations are well known for having highly fluctuating densities and as a result, their growth rates are highly density dependent. Density-dependent growth results in decreased mean length at maturity at increased densities and is common in kokanee populations (Rieman and Myers 1992; Rieman and Maiolie 1995). Wide fluctuations in kokanee density have been especially evident at Deadwood Reservoir as the kokanee population experiences fluctuating levels of angling effort and has five tributaries with excellent spawning habitat. The reservoir also supports low densities of piscivores that have historically had little impact on kokanee abundance. From 2006 to 2011, we sought to reduce kokanee abundance and increase mean length by limiting escapement into a number of the Deadwood Reservoir tributaries (Kozfkay et al. 2010). High flow events that washed out the picket weirs and access restrictions due to forest fires contributed to the variable success of these efforts. However, efforts were considered successful in most years. Subsequent periodic monitoring of these tributaries has indicated little to no kokanee spawning. In addition, continued restricted escapement above the Deadwood Weir also helped limit production. However, these restrictions were too effective in limiting kokanee production as kokanee numbers dropped below a level satisfactory to meet statewide early-run egg needs from 2015 to 2017. Egg collection efforts at Deadwood Reservoir were discontinued for one year in 2009 to evaluate the South Fork Boise River weir location. Egg collection and escapement management efforts resumed in 2010 and continued through 2016. However, a continued downward trend in the Deadwood Reservoir kokanee population led to collection efforts on the Deadwood River being discontinued again in 2017. Instead, the North Fork Clearwater River was evaluated as a potential alternative early run kokanee egg source. However, the Deadwood kokanee populations has begun to rebound and minimum egg needs were again met in 2018.

Estimates of kokanee angling effort and corresponding potential harvest impacts have long been anecdotal at Deadwood. However, with recent declines in kokanee numbers and the corresponding increase in kokanee size, managers were concerned that the combination of large kokanee and liberal bag limits (25 fish per day) were resulting in a high level of overall angler harvest in the Deadwood fishery, further impacting subsequent egg take. We conducted an angler creel in the summer of 2018 to formally evaluate the impact that kokanee anglers are having on the kokanee population.

METHODS

The pelagic fish species composition in Deadwood Reservoir was assessed using seven curtain gill nets set over two nights at three separate locations (seven total net-nights; Figure 9). Site one and two were sampled on the evening of June 14, 2017. Three nets were suspended at offsetting depths in the water column with focus on the kokanee layer. At each of the two sites, one net was suspended from 3 to 6 m, one from 6 to 9 m, and one from 9 to 12 m. At site three, a single net was suspended on the evening of June 15, 2017. This net was set at a depth from 2 to 5 m. Nets were 55 m wide x 6 m deep and made up of 18 separate, 3-m wide panels comprised of 13, 19, 25, 38, 51, 64, 76, 89, and 102 mm stretch mesh. The nine various sized panels were each repeated twice, randomly, throughout the length of the net.

Captured fish were identified to species and measured for total length (± 1 mm). Larger kokanee were necropsied to determine sex, maturity, fecundity, and to assess mean length of females during the spawning run. Catch data were summarized as the number of fish caught per unit of effort (CPUE, fish/net-night). All kokanee otoliths were removed for determining age using sectioned whole otoliths. We estimated the age of kokanee using two agers and discrepancies between agers were settled via discussion and image review among agers and the aid of fish length. Previous year's gill net CPUE of age-2 and age-3 kokanee was regressed against total adult kokanee that returned to the Deadwood River weir in the same year. This linear regression is used to generate an in-season estimate of kokanee that will return to the weir based on summer gill net catch.

A total of 12 creel surveys of kokanee anglers were conducted from mid-June through mid-July, 2018. Six of the creel dates were randomly assigned to weekend days and six were randomly assigned to weekdays. Creel days were stratified into two shifts. An AM shift ran from 0700 hours to 1430 hours and a PM shift ran from 1430 hours to 2200 hours. Six of the creel dates were randomly assigned an AM creel schedule and the remaining six were creeled in the PM. Creel surveys were conducted as both roving and access. Because Deadwood Reservoir is small enough and access is limited, many anglers beach their boats and camp along the shoreline. In an effort to interview anglers that had completed their trips, creel clerks moved around to different camps and access points to intercept anglers that had completed their fishing. In addition to angler interviews, instantaneous angler counts (via boat counts) were conducted at three randomly assigned times throughout each survey period.

We generated estimates of kokanee harvest following the methods outlined in McCormick and Meyer (2017). We estimated total angling effort in angler- hours on day *d* as

$$\hat{E}_d = T_d \bar{I}_d,$$

where T_d is the total number of hours in the fishing day and $\bar{I}_d$ is the mean of the angler counts (average number of boats from instantaneous counts multiplied by average number of anglers per boat) conducted on day *d.*

We then generated effort of weekday and weekend strata (*k)* as

$$\hat{E}_k = N_k \frac{\sum_{d=1}^{n_k} \hat{E}_d}{n_k},$$

where N_k is the number of days in the stratum and n_k is the number of days surveyed in the stratum. Estimates of effort among strata were summed to estimate effort ($\hat{E}$) over the duration of the kokanee fishing season.

Mean angler catch rate using a daily estimator in fish per angler-hour on day *d* was estimated as

$$\hat{R}_d = \frac{\sum_{i=1}^{j_d} c_{d,i}}{\sum_{i=1}^{j_d} h_{d,i}},$$

where j_d is the total number of anglers interviewed on day d; c_d is the number of fish caught by the ith angler on day d; and h_d is the total number of hours fished by the ith angler on day d.

Catch of day d was estimated as

$$\hat{C}_d = \hat{R}_d \hat{E}_d.$$

While catch for the stratum was estimated as

$$\hat{C}_k = N_k \frac{\sum_{d=1}^{n} \hat{C}_d}{n_k}.$$

Estimated catch among strata was then added to estimate sample period catch and sample period catch was expanded to the length of the entire season (estimated to be 10 weeks) to generate a catch estimate across the entire kokanee season.

RESULTS

A total of 231 fish were captured in gill nets during the pelagic survey (Table 6). Approximately 84% of the catch was kokanee (n = 194), followed by Mountain Whitefish *Prosopium williamsoni* (17%; n = 32). Chinook Salmon, Westslope Cutthroat Trout and Rainbow Trout were also captured, but in very low numbers. The kokanee captured in the gill nets ranged from 109 to 410 mm (Figure 10) and were composed of three age classes (ages 1-3; Figure 11). Kokanee CPUE was 27.7 fish/net-night (Table 6). By comparison, kokanee CPUE was 5.7 fish/net-night in 2017 and 6.5 fish/net-night in 2016. (Cassinelli et al. 2018). Mean TL of mature female kokanee was 298 mm, while mature males averaged 314 mm. Age-specific CPUE of kokanee in 2018 was 10.6 fish/net-night for age-1, 12.6 fish/net-night for age-2, and 15.6 fish/net-night for age-3. The estimated adult return to the Deadwood weir based on gill net catch was 54,700 kokanee.

Total length of Mountain Whitefish ranged from 320 to 420 mm, and CPUE was 4.6 fish/net-night. Average length of the three Rainbow Trout sampled was 345 mm, and CPUE was 0.4 fish/net-night. Total length of the one Westslope Cutthroat Trout was 510 mm while the single Chinook Salmon length was 462 mm. CPUE for both species was 0.1 fish/net-night (Table 6).

We interviewed 327 total kokanee anglers across 12 creel dates from mid-June through mid-July. On average, we interviewed 24 anglers on weekdays and 31 anglers on weekend days. Weekdays averaged 5.8 boats per count with 2.3 anglers per boat, while weekend days averaged 6.1 boats per count with 2.8 anglers per boat (Table 7). Average weekday effort was 210 hours with 1.5 kokanee caught/hour for an average catch estimate of 318 kokanee per weekday. Average weekend day effort was 262.5 hours with 1.4 kokanee caught/hour for an average catch estimate of 359 kokanee per weekend day (Table 7). The average trip duration for anglers we interviewed was 6.5 days. Extrapolated over the entire 10 week kokanee season at Deadwood, total kokanee fishing effort was 18,050 hours with a harvest estimated of 26,300 fish. Based on both length and otolith age assignments, 20% (5,260) of the harvest was estimated to be age-2 while the remaining 80% (21,040) were estimated to be age-3.

DISCUSSION

Gillnetting with curtain nets has been occurring at some level in Deadwood Reservoir since 2013 (Figure 12). Initially, gillnetting was used as a supplement to previous hydroacoustic sampling. However, since 2017, gillnetting had been the primary kokanee sampling technique used at Deadwood Reservoir following the results of a University of Idaho doctoral research project. This project showed that using overnight experimental curtain gill net sets, suspended in the kokanee layer of the water column, appears to be the most effective tool to capture and monitor kokanee populations (Kline et al. 2019). Each additional year of netting data builds on the accuracy of the relationship between CPUE of netted adults (and the associated size of mature females) and the escapement to the Deadwood River. However, we currently have four years (2013, 2015, 2016, and 2018; 2014 catch was under-representative due to alternative net locations and 2017 there was no weir) of net and catch data that show a relatively strong relationship that can serve as a predictor of weir returns based on age 2 and 3 gill net catch (Figure 13).

Management of the kokanee within Deadwood Reservoir remains difficult given the numerous goals associated with the population. Our desire is to manage for a population that is abundant enough to provide adequate juvenile kokanee prey for the growth of trophy-sized trout and salmon, but not so abundant that adult kokanee size is reduced enough to discourage kokanee anglers or reduce the efficiency of an egg take. Given our current knowledge of the density-dependent growth relationship at Deadwood, a target female length of about 305 mm appears ideal to achieve our management goals. However, managing kokanee abundance in a highly productive system with multiple spawning tributaries such as Deadwood, remains difficult and we recognize the population will continue to fluctuate around specific goals.

Adding to the difficulty of managing the kokanee population in Deadwood is the reservoir's increasing popularity as a sport fishery, especially among anglers targeting kokanee. Despite the reservoir's remoteness and accessibility only by multiple miles of dirt road, the 25 fish/day bag limit and recent larger than average sized adult kokanee have made this fishery even more popular in recent years. Kokanee size influences angler's perception of the quality of the fishery and that larger kokanee are more easily exploited by anglers (Martinez and Wiltzius 1995; Rieman and Maolie 1995). Prior to 2018, IDFG didn't have a good understanding of the impacts that a 25 fish daily bag limit (75 fish possession limit) was having on the adult spawner population. When population numbers are low, average fish size is high, and angler effort increases. We estimated that 26,300 adult kokanee were harvested in the sport fishery in the summer of 2018, while roughly 20,000 adults subsequently returned to the Deadwood River. When combining the sport fishery harvest with the adult returns to the Deadwood River, harvest accounted for nearly 57% of the adults. This harvest portion is likely biased high as there are additional adults in the system that spawn in the reservoir's other tributaries, but fall walks along sections of all these tributaries showed that spawning was limited. Martinez and Wiltzius (1995) noted when adult kokanee exceeded 367 mm in Lake Gramby, Colorado, more than 50% of them were harvested in the summer recreational fishery. Askey and Johnston (2013) found that reductions to kokanee bag limits at Okanagan Lake in British Columbia were largely ineffective in altering harvest rate or effort dynamics in that fishery. However, those authors were only evaluating the effects of angler harvest on subsequent natural production. Deadwood is unique in two aspects. Firstly, there is the added spawning requirements for the hatchery egg take for our statewide program. Secondly, given its remoteness and difficulty to get to, Deadwood is a destination fishery where anglers often stay for multiple days. The average trip duration for anglers we interviewed was 6.5 days. None of the anglers we interviewed harvested more than 15 fish in a single day. However, because of the extended duration of their trips, some anglers were staying long enough to catch their possession limit of 75 fish (three times the daily bag limit) and 30% of anglers left the reservoir with more than 50 fish in possession. Given the increased popularity of this kokanee fishery and significant harvest impact, IDFG suggested reducing the daily kokanee bag limit to 15 fish (resulting in a 45 fish possession limit) starting in 2019. Based on trip duration and possession limits, we estimated this bag reduction would reduce adult kokanee harvest by roughly 20% while still providing a liberal enough limit to encourage anglers to make the long trip to Deadwood. This proposed rule change was adopted by the Commission and will take effect in 2019.

The higher CPUE of age-1 and age-2 kokanee in gill nets is promising, suggesting that the kokanee population in Deadwood Reservoir appears to be rebounding following the low numbers observed in 2017. Additionally, the reservoir was stocked with over 67,000 hatchery fingerling kokanee in 2018 to help the population recover more quickly. As in past years, early summer netting when the reservoir becomes accessible will provide further insight into spawner abundance and aid in planning egg take operations and managing escapement.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring the kokanee population in Deadwood Reservoir with gill nets and sample pre-spawning fish to generate age-specific CPUE and length-at-age to estimate potential spawners in 2019.
2. Maintain annual stocking of 2,000 – 3,000 adipose-clipped fall Chinook Salmon fingerlings in spring or early summer.
3. Stock hatchery fingerling kokanee in Deadwood Reservoir in June 2019.
4. Assist in weir operations on the Deadwood River to manage escapement and collect broodstock for egg collection.

Table 6. Total catch and catch per unit effort (CPUE) by species in seven gill nets set in Deadwood Reservoir, Idaho on June 13-14, 2018.

Species	Total catch	Total CPUE
Kokanee	194	27.7
Mountain Whitefish	32	4.6
Rinabow Trout	3	0.4
Westslope Cutthroat Trout	1	0.1
Chinook Salmon	1	0.1
Total	231	33.0

Table 7. Interview date-specific metrics including number of anglers interviewed, average instantaneous boat counts, average anglers per boat and estimates of daily effort, catch rate, and total catch for Deadwood Reservoir creel in 2018.

Survey date	Day type	Fishing hours	Anglers interviewed	Avg. boat count	Avg. ang/boat	Total daily effort	kokanee caught/hour	Daily catch estimate
6/18/2018	WD	15.6	31	4.0	2.0	124.4	2.11	262
6/25/2018	WD	15.5	12	4.7	2.5	181.3	1.84	333
7/3/2018	WD	15.5	45	5.0	2.4	185.4	1.35	251
7/4/2018	WD	15.4	5	6.3	1.5	146.6	1.73	253
7/10/2018	WD	15.3	29	6.0	2.8	257.0	0.91	233
7/11/2018	WD	15.3	22	9.0	2.8	385.6	1.15	445
Weekday average		*15.4*	*24*	*5.8*	*2.3*	*210.0*	*1.5*	*318*
6/16/2018	WE	15.5	49	9.0	4.5	629.6	1.13	710
6/17/2018	WE	15.6	17	6.0	1.6	149.3	2.73	407
6/23/2018	WE	15.5	21	5.3	2.9	240.5	1.27	306
6/24/2018	WE	15.5	30	7.3	2.5	285.0	1.52	434
6/30/2018	WE	15.5	17	2.3	2.8	101.2	0.47	48
7/1/2018	WE	15.5	49	6.7	2.3	237.4	1.07	255
Weekend average		*15.5*	*31*	*6.1*	*2.8*	*262.5*	*1.4*	*359*

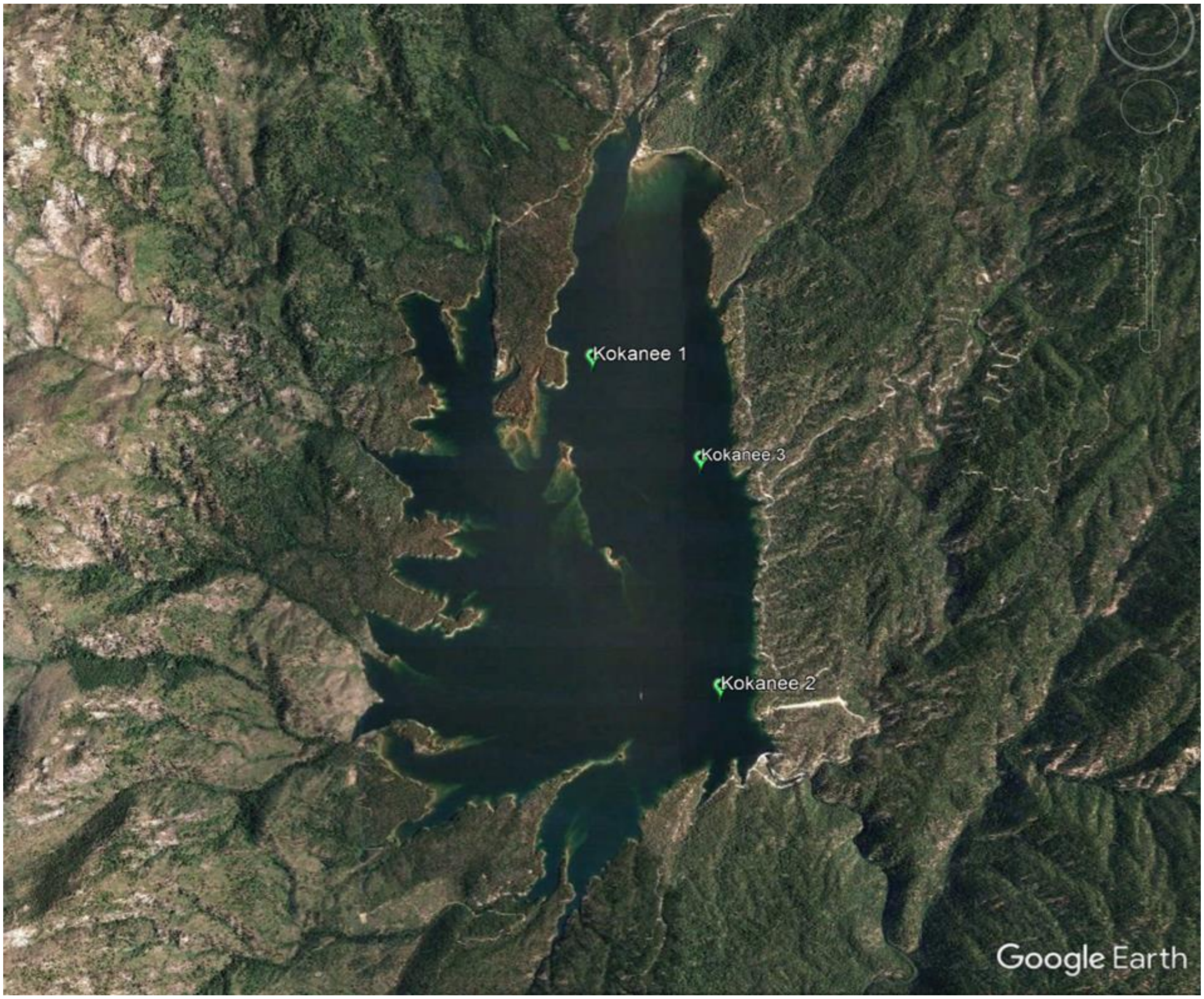


Figure 9. Image of Deadwood Reservoir, Idaho showing curtain gill net locations used in 2018 sampling.

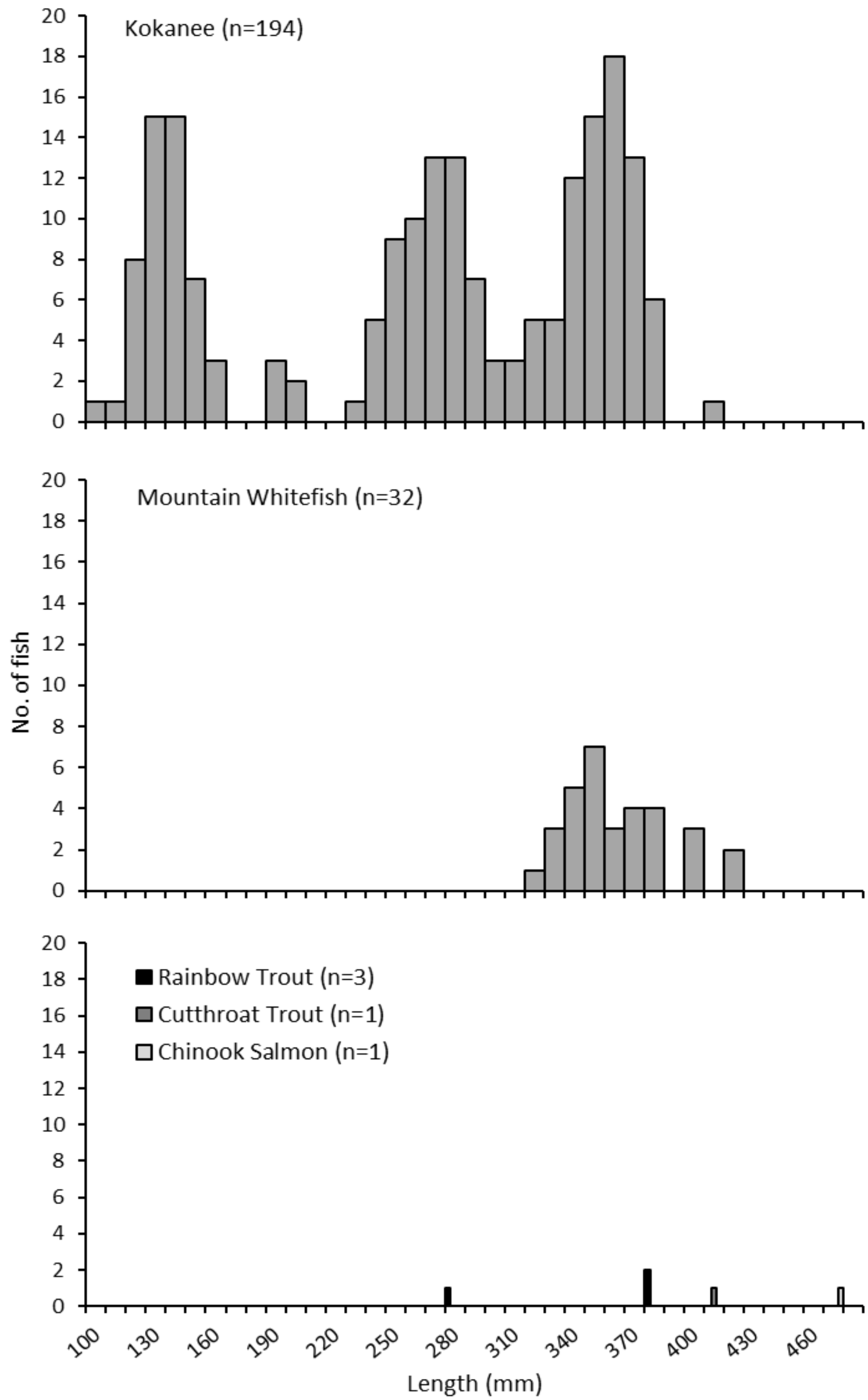


Figure 10. Length frequency distributions for kokanee, Mountain Whitefish, Rainbow Trout, Westslope Cutthroat Trout, and Chinook Salmon caught in curtain gill nets at Deadwood Reservoir, Idaho on June 13-24, 2018.

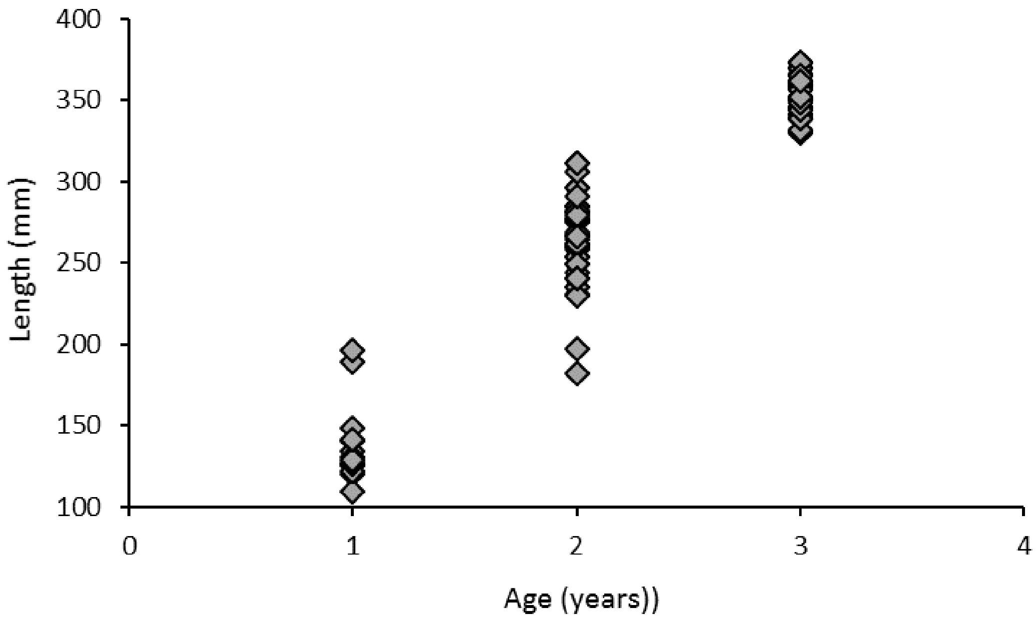


Figure 11. Length-at-age of kokanee sampled in Deadwood Reservoir pelagic gill nets (June 2018).

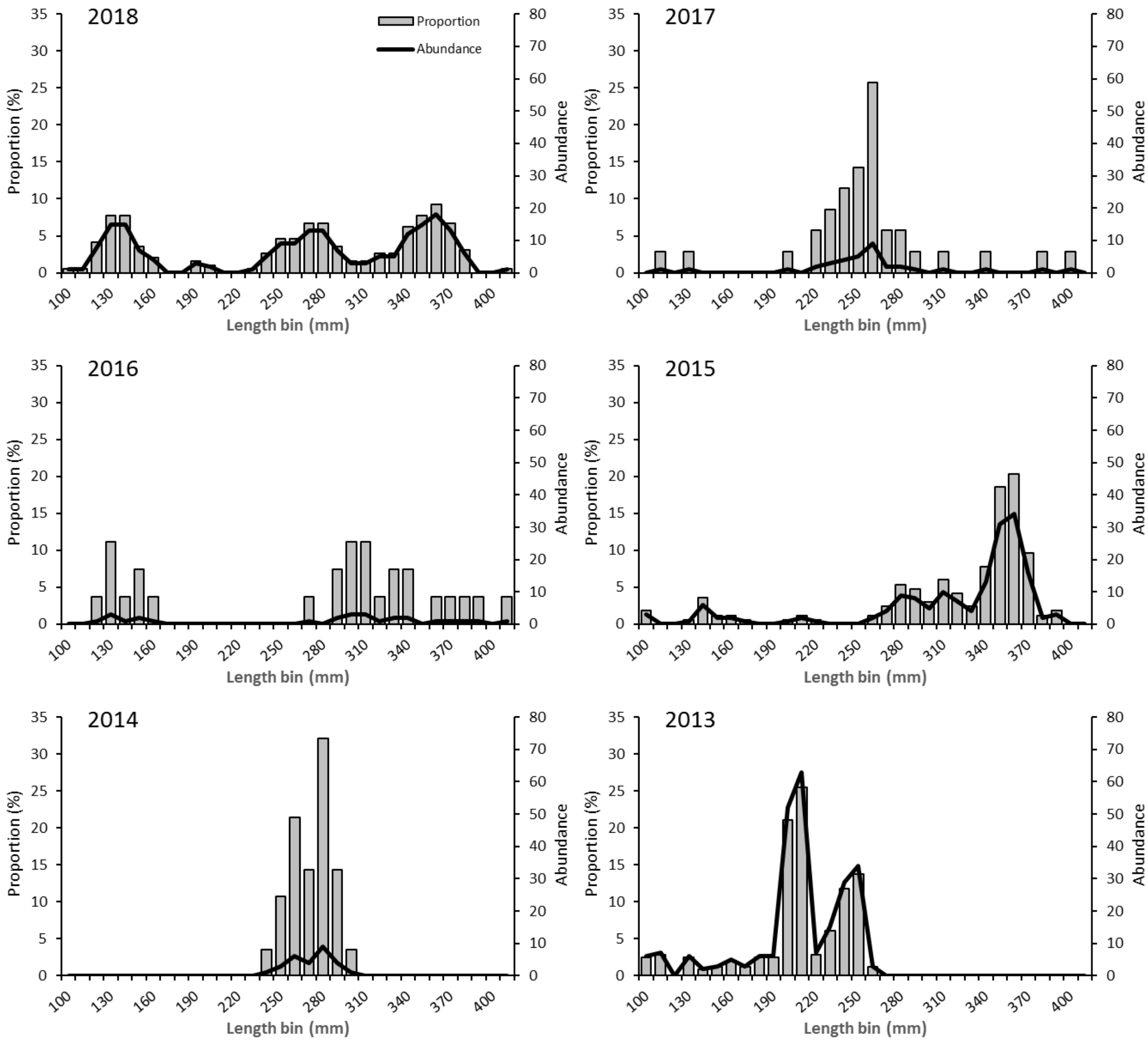


Figure 12. Length distributions for kokanee caught in curtain gill nets at Deadwood Reservoir, Idaho from 2013-2018. Gray bars are the proportion of the catch by size and black lines are the overall abundance by size.

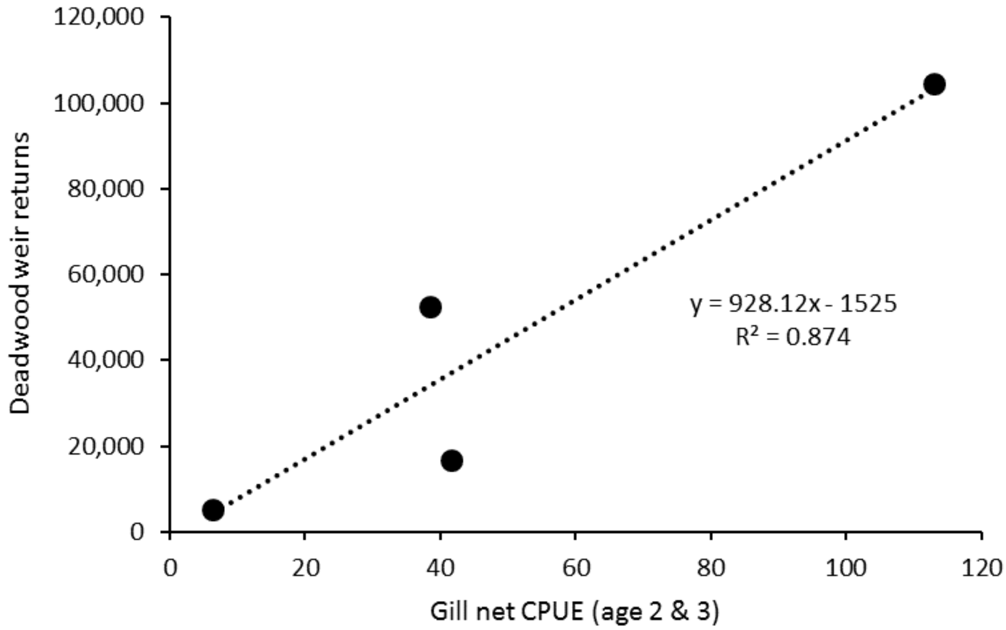


Figure 13. Deadwood Reservoir June gill net CPUE of age-2 and age-3 adult kokanee vs. returns to the Deadwood River weir in August and September for 2013, 2015, 2016, and 2018.

ASSESSMENT OF PANFISH POPULATION DYNAMICS IN CJ STRIKE RESERVOIR

ABSTRACT

Panfish species found in CJ Strike Reservoir are very popular recreational angling opportunity. In 2016, we began the first year of a multiyear investigation to better understand of crappies (both Black Crappie *Pomoxis nigromaculatus* and White Crappie *Pomoxis annularis*) and Yellow Perch *Perca flavescens* population dynamics and to learn how anglers utilize these species in the fishery. In both spring and fall 2018, we completed surveys using standardized lowland lake sampling gears to index relative abundance of panfish species and index creel surveys, similar to 2017. Continued monitoring of larval fish production was completed to identify peak larval mean densities for crappies and Yellow Perch. Otter trawl gear was used in the fall to index relative abundance of panfish species prior to winter. We interviewed 373 anglers during the index creel surveys in 2018. Harvest rates were higher for crappies and Yellow Perch during the fall. Ages of harvested crappies and Yellow Perch varied between seasons. Total catch-per-unit-effort (CPUE) in the spring using standardized gear for crappies and Yellow Perch were 61 and 49, respectively. Age-1 crappies and age-3 Yellow Perch had the highest CPUE in the spring survey. Peak larval crappies abundance was 35.4 fish/100 m^3, which represented an increase of 48% above the mean since 2005. Total CPUE in the fall using standardized gear for crappies and Yellow Perch were 94 and 98, respectively, much higher than the spring survey. Otter trawl surveys included 12 tows and species composition consisted of mainly crappies (54%), Yellow Perch (30%), and Bluegill (16%). Age and growth data were similar to data observed during the first two years of the assessment. Continued use of existing gear types and systematic sampling to develop indices of relative abundance should provide us with increased understanding of these populations.

Author:

Michael P. Peterson
Regional Fishery Biologist

INTRODUCTION

Panfish (e.g. crappies *Pomoxis* spp., Yellow Perch *Perca flavescens*, and Bluegill *Lepomis macrochirus*) commonly provide angling opportunity in many Idaho waters. One of the most popular and robust fisheries for panfish in Idaho may be found at CJ Strike Reservoir. According to creel data collected by Idaho Power Company (IPC) between 1994 and 2009, anglers expended an average of 260,000 hours annually at CJ Strike Reservoir (Brown et al. 2010). This fishery is important to local economies. Economic survey data from 2011 estimated CJ Strike Reservoir ranked sixth in statewide spending and first in total angler trips (IDFG, unpublished data). Both of these survey efforts indicated that much of the angling effort and expenditures were directed at panfish (Brown et al. 2010).

Crappie populations and fisheries in CJ Strike Reservoir appear to be cyclic and can fluctuate dramatically from one year to the next. In years when crappies are abundant, the proportion of anglers targeting crappie may more than double (Brown et al. 2010). The most recent large year class of crappies was produced in 2006 and provided substantial fisheries in 2008, 2009, and later, though creel information wasn't collected after 2009 (Brown et al. 2010). Very high larval densities were sampled in the Bruneau River arm during 2006. These larval crappies survived at a high rate, but were not sampled again in a meaningful way until 2009. Electrofishing catch per unit effort (CPUE) for Black Crappie *Pomoxis nigromaculatus* during the 2009 lowland lake survey was 23 times higher than the highest observed CPUE from five previous surveys (1995-2000; Butts et al. 2011). This year class declined in abundance after 2010, and no major year classes have contributed to the fishery since, despite occasionally high larval production.

Yellow Perch populations appear to be cyclic as well. Past creel survey data indicated the contribution of Yellow Perch to overall harvest ranged from a high of 40% (Allen et al. 1995) to a low of 3% (Flatter et al. 2003). Similar fluctuations have been observed in electrofishing CPUE which ranged from a low of 1 to 159 fish/h (Butts et al. 2011). Angler preference for Yellow Perch appears to vary across years as well. In the 1992 creel survey, anglers indicated they targeted Yellow Perch roughly 10% of the time (Allen et al. 1995), whereas in a survey conducted by Idaho Power from 2007 to 2009, results varied from 6 to 23%. Currently, population dynamic information for Yellow Perch in CJ Strike Reservoir is incomplete. Past surveys have provided limited length-at-age data. Unlike with crappies, a Yellow Perch focused study has not been conducted for CJ Strike Reservoir.

Population fluctuation and the factors that affect panfish recruitment to these populations and fisheries are currently not well understood. Fisheries personnel are interested in (1) developing techniques to sample panfish that allow quantification of abundance at several life stages or ages, (2) monitoring changes in abundance and other parameters for several years, (3) comparing biotic and abiotic factors that may influence abundance, (4) gaining an understanding if and how angling impacts panfish populations, and (5) modeling population parameters to evaluate whether restrictive rules are needed. The primary focus of this assessment will be on crappies and Yellow Perch populations within CJ Strike Reservoir. However, when possible, data will be collected for Smallmouth Bass *Micropterus dolomieu* and Bluegill to increase our understanding of these populations.

Year-class strength for crappies and Yellow Perch may be determined at early life stages; whether this occurs before or after the first winter is currently unknown. A Neuston net has been towed at ten locations on CJ Strike from 2005 to 2016 (Butts et al. 2016). This tool is more effective at sampling larval crappies rather than Yellow Perch and provides an index of relative abundance.

Peak larval densities have averaged 17 fish/100 m^3 (10-year average; Butts et al. 2016). However, in 2006, densities averaged 58 fish/100 m^3 and produced crappies in the fishery 2-4 years later. A statewide research project initiated in 2005 hypothesized that peak larval density would be a useful index for predicting year-class strength of crappies unless substantial overwinter mortality occurred (Lamansky 2011). In contrast, the project found no consistent relationship between peak larval densities and year-class strength (Lamansky 2011), suggesting that other factors limiting early survival could be driving recruitment. Quantifying larval production and subsequent survival needs further investigation.

Data for age-1 and older crappies and Yellow Perch are limited for the CJ Strike Reservoir populations. Several lowland lake surveys conducted on the reservoir provided CPUE and length-frequency data (Butts et al. 2011). However, life-stage mortality for crappies or Yellow Perch were not investigated. Meyer and Schill (2014) used nonreward tags to generate annual mortality rates for crappies, which ranged from 50-86% for the entire population (i.e. not year-class specific). Lamansky (2011) investigated age and growth data for crappies populations throughout the state, which included CJ Strike Reservoir. Crappies sampled in CJ Strike Reservoir had relatively fast growth and very few crappies older than age-3 were observed (Lamansky 2011), which suggests a population that exhibits high annual mortality, as observed by Meyer and Schill (2014). Age data for crappies collected in other Southwest Region waters suggest that crappies can survive to age-6 or older (Butts et al. 2013). Describing life-stage specific mortality rates may help identify population bottlenecks, which, if manageable, may increase recruitment of crappies (or Yellow Perch) to future fisheries.

Extensive research has been completed throughout the range of crappies to identify biotic and abiotic factors that affect recruitment in populations. Biotic factors such as size of spawning stock (Fayram et al. 2015; Bunnell et al. 2006), intraspecific and interspecific competition, as well as predation (Pope and Willis 1998; McKeown and Mooradian 2002; Parsons et al. 2004) have been shown to affect recruitment. Abiotic factors such as water levels (Sammons et al. 2002; Maceina 2003; Fayram et al. 2015), water temperatures (Pine and Allen 2001; McCollum et al. 2003), and the physical and chemical make-up of the waterbody (Bunnell et al. 2006) have also been shown to affect recruitment in crappie populations. Wisconsin's Department of Natural Resources recently released two relevant literature reviews that address management approaches for crappies and Yellow Perch based on biotic and abiotic factors (Fayram et al. 2015; Niebur et al. 2015) and implemented a 10-year strategic plan for managing panfish within the state (Hansen and Wolter 2016). A study in Missouri reservoirs found that multiple factors, both biotic and abiotic, likely add complexity to understanding crappies recruitment (Siepker and Michaletz 2013). Studies suggest lake or reservoir-specific studies are needed before appropriate management strategies may be implemented (Lamansky 2011; Fayram et al. 2015). Implementing the work described later in this document would generate population-specific data to improve understanding, especially relating to abundance fluctuations and determine whether management strategies should be altered to maintain or improve crappies or Yellow Perch fisheries in CJ Strike Reservoir.

Currently, no bag or length limits have been placed on CJ Strike Reservoir panfishes, and these populations are managed for maximizing harvest opportunity. In other systems and states, biologists have studied the effects of restrictive regulations such as bag limits (Allen and Miranda 1995; Mosel et al. 2015) and minimum length limits (Isermann et al. 2002; Mosel et al. 2015) and suggested that natural mortality, angling mortality, and growth rates of a population need to be fully understood prior to deciding whether regulation changes are warranted. The Southwest Region repeatedly receives requests from anglers to implement restrictive regulations on crappies (most often a bag limit) with the hope of providing stable fishing opportunities on these cyclic fisheries. In some systems, minimum length limits have been shown to increase both abundance and size structure in crappies (Allen and Miranda 1995; Isermann et al. 2002; Mosel et al. 2015) and Yellow Perch (Mosel et al. 2015) populations. However, the benefits associated with bag limits or minimum length limits could be negated if the population exhibits slow growth and high natural mortality rates (Mosel et al. 2015; Isermann et al. 2002). Therefore, due to the lack of available growth and mortality data, informed decisions regarding restrictive fishing rules cannot currently be made. Prior to assessing the need for regulation changes (e.g. bag or minimum length limits), data specific to CJ Strike crappies and Yellow Perch needs to be collected, analyzed, and modeled to predict whether these management tools can benefit sportfishing within the reservoir.

The panfish assessment initiated in 2016 to increase our knowledge of population dynamics within CJ Strike Reservoir was continued in 2018. Several long-term survey designs began in 2016. An index creel survey was established, in both spring and fall, to learn how anglers utilize panfish species within the reservoir. The use of otter trawl gear was investigated to develop an index of relative abundance and monitor survival from larval production to winter. In 2017, spring and fall population indexing were initiated utilizing lowland lake survey gears (e.g. electrofishing, trap nets and gill nets). Data generated from the spring relative abundance index will be used to assess whether overwinter mortality is a limiting factor that affects recruitment of young-of-the-year (YOY) crappies and Yellow Perch to future fisheries. In addition, the data generated from the fall relative abundance index will allow us to identify whether larval fish survive to enter their first winter or if a survival bottleneck exists prior to fall. The spring and fall surveys also allow us to monitor older age classes of crappies and Yellow Perch at multiple life stages. Finally, ZQI sampling was established to determine whether zooplankton production affects panfish growth.

STUDY AREA

CJ Strike Reservoir is primarily managed for hydroelectric power production and water storage. The reservoir experiences minimal water fluctuations throughout the year. Elevation of the reservoir is approximately 750 msl. The reservoir is geologically characterized as the Snake River plain, which consists of sedimentary and volcanic deposits (IDEQ 2006). CJ Strike Reservoir is listed as an impaired waterbody by the Idaho Department of Environmental Quality because of nutrients and pesticides (IDEQ 2006). The reservoir is 3,035 ha and provides habitat for a wide variety of fish species ranging from cold water (e.g. White Sturgeon *Acipenser transmontanus* and Rainbow Trout *Oncorhynchus mykiss*) to warm water species (e.g. Black Crappie and Largemouth Bass *Micropterus salmoides*). The reservoir is influenced by two major water sources (Snake and Bruneau rivers) and can be split into three distinctive segments (or strata): Bruneau River arm (1,123 ha), Snake River arm (759 ha), and the main pool (1,153 ha). The Bruneau Arm is relatively shallow, warm, turbid, and typically has a low turnover rate from the much smaller discharge from the Bruneau River drainage, whereas the Snake Arm is deeper, clearer, and has a higher turnover rate (Butts et al. 2011). These differences in environmental factors may influence primary productivity, fish reproductive success, or recruitment (Butts et al. 2011).

MANAGEMENT GOAL

Maintain or improve sportfishing opportunities for panfish species (specifically Black Crappie, White Crappie *Pomoxis annularis*, and Yellow Perch) in CJ Strike Reservoir, Idaho through increased understanding of population dynamics and angler utilization.

OBJECTIVES

1. Identify optimal techniques (e.g. larval trawling, otter trawling, trap netting, gillnetting, and electrofishing) for monitoring primary panfish populations in CJ Strike Reservoir at several life stages.
2. Develop and implement annual, consistent monitoring efforts.
3. Estimate key parameters that describe population dynamics of crappies and Yellow Perch (e.g. index of stock, length frequency, age frequency, age and growth, total mortality, fishing mortality, age at first reproduction, and length at first reproduction).
4. Estimate key parameters that describe angler harvest of crappies and Yellow Perch.

METHODS

Angler Catch Rate

Six fixed dates were randomly selected (three weekdays and three weekend days) for a spring and fall index creel survey. Fixed dates are defined as the same day of each year (e.g. the first Tuesday of May). The spring survey was conducted between April 15 through June 15 and the fall survey between August 15 and October 15. Selected dates were subdivided into two five-hour time periods (0900 to 1400 h and 1500 to 2000 h), of which one time period was randomly selected for each date. The two most popular boat ramps located at CJ Strike Reservoir were selected as suitable locations to collect data: the Air Force or Cottonwood boat ramps. Anglers were surveyed at the completion of their trip. This survey design is similar to a portion of the access-access survey design described by Pollock et al. (1994).

Catch rates were determined from angler interviews. Only complete trip information was used for catch rate estimation to avoid bias associated with incomplete trips (MacKenzie 1991; Hoenig et al. 1997). Party size, primary target species, harvest by species, release by species, and angler residency were collected during interviews. Interviews were conducted on an individual basis. Interview data were summarized as the ratio of means. Catch rates were derived using the multiday estimator found in McCormick and Meyer (2017). Variance and 90% confidence bounds were calculated using formulae 12, 13, and 14, found in McCormick and Meyer (2017).

Angler harvest and total catch was estimated for crappies and Yellow Perch using 70 mm (51 mm of tubing) fluorescent orange Floy® FD-68BC T-bar anchor tags injected just beneath the dorsal fin. Fish were tagged during several sampling events and only fish ≥ 200 mm were tagged. Tag reporting data was collected using the IDFG Tag! You're It! phone system and IDFG website. We calculated angler harvest and total catch rates of crappies and Yellow Perch from reported tags and the analysis methods presented in Meyer et al. (2010) and Koenig (2012). Tag reports were adjusted using a non-reward tag reporting rate of 59.7% and 58.5% and a 1-year tag loss rate of 2.8% and 1.2% for crappies and Yellow Perch, respectively (Unpublished IDFG Data). Tag reporting data was analyzed for a 365-day duration after release for fish tagged in 2017.

Spring Relative Abundance

Fish populations in CJ Strike Reservoir were sampled with standard IDFG lowland lake sampling gears from May 14 to 16, and on May 21, 2017. Sampling gear included: (1) paired sinking/floating gill nets, (2) trap nets, and (3) night electrofishing. Paired gill net sets included floating and sinking monofilament nets, 46 m x 2 m, with six panels composed of 19, 25, 32, 38, 51, and 64-mm bar mesh. One floating and one sinking net, fished for one night, equaled one unit of gill net effort (fish/effort, hereafter f/e). Trap nets possessed 15-m leads, 1-m x 2-m frames, crowfoot throats on the first and third of five loops, 19-mm bar mesh, and had been treated with black tar. One trap net fished for one night equaled one unit of trap net effort (f/e). For boat electrofishing effort, a Midwest Lake Electrofishing System (MLES) Infinity system set at 20% duty cycle and approximately 2,200-2,800 watts of pulsed DC power generated by a 6,500-watt Honda generator was used. One hour of active on-time electrofishing equaled one unit of effort. Due to the relatively large size of CJ Strike Reservoir, we divided the reservoir into three sections (strata): Bruneau River arm, main pool, and the Snake River arm. We used equal amounts of effort in each of the strata, including 1 h of electrofishing effort (divided into six, ten-minute runs), seven trap nets, and four paired gill net sets. In total, 21 trap net sets, 12 paired gill net sets, and 3 h of electrofishing were utilized during 2018 (Figure 14). The current survey design was similar to the last lowland lake survey conducted on CJ Strike in 2009 (Butts et al. 2011). A randomized sampling protocol was implemented to collect representative samples of fish populations throughout the reservoir. Within each stratum, Google Earth Pro (version 7.1.7.2606) was used to estimate the length of the shoreline and to quantify the number of 500 m (in length) sample sites that occurred in each strata. Nets (gill or trap nets) were deployed or electrofishing was conducted within the selected location. Sites were selected randomly using a random number generator and will continue to be sampled in subsequent years.

Captured fish were identified to species, measured for total length (± 1 mm), and weighed (±1 g for fish under 5,000 g or ± 10 g for fish greater than 5,000 g) with a digital scale. In the event that weight was not collected, weights of un-weighed fish were estimated from length-weight relationships from weighed fish. Furthermore, for those fish not weighed or measured, average or estimated weights were used to calculate biomass estimates. Catch data were summarized as the number of fish caught-per-unit-effort (CPUE). After CPUE was calculated for each gear type, the estimates were summed together to calculate total CPUE (e.g. electrofishing CPUE + trap net CPUE + gill net CPUE = total CPUE). Indices were calculated by standardizing the catch of each gear type to one unit of effort and then summing across the three gear types. Relative weight (W_r) was calculated as an index of general fish body condition where a value of 100 is considered average. Values greater than 100 describe robust body condition, whereas values less than 100 indicate less than ideal foraging conditions. Proportional size distribution (PSD) was calculated for gamefish populations as outlined by Anderson and Neuman (1996) to describe population size structure. Stock size used for crappies and Yellow Perch was 130 mm, with 200 mm being used as quality size (Gabelhouse Jr. 1984).

Larval Fish Production

Horizontal surface trawls were used to sample larval fish at 10 sites in CJ Strike Reservoir. Trawls were conducted throughout the reservoir (Figure 15) using a 1 m high x 2 m wide x 4 m long Neuston net with 1.3 mm mesh. Trawling commenced at dusk and all sites were completed within three to four hours. Each trawl was five minutes in duration and we used a flow meter fitted to the net to estimate the volume of water sampled. Trawling was conducted on five separate dates including June 4, June 11, June 19, June 26, and July 2, 2018. These dates overlapped peaks of crappies production in previous years. Specimens were fixed in 10% formalin for two weeks then rinsed and stored in 70% ethanol. Sampled fish were viewed under a dissecting microscope, identified to species, and measured for length. If the total number of larval fish exceeded 50 individuals, we randomly selected a subsample of 50 individuals, identified and measured those, then counted the remainder and extrapolated to the whole sample. The week that had the highest crappies densities averaged across all sample sites was indexed as the peak larval density for the year and reported as fish/100 m^3. Data were compared across years to categorize trends in crappies production. Zooplankton quality index (ZQI) was initiated in the spring of 2017 and continued in 2018. ZQI methodology can be found in Teuscher (1999). ZQI sampling was conducted at three sites within the reservoir, once a month, beginning May 21 and ending October 15, 2018, which is assumed to be when larval panfish would be utilizing zooplankton the most.

Fall Relative Abundance

Crappies and Yellow Perch populations in CJ Strike Reservoir were sampled again in fall with standard IDFG lowland lake sampling gears from October 15 to 17, and on October 22, 2018. Sampling gears included those referenced above and the survey consisted of the same units of effort (e.g. one floating and one sinking net, fished for one night, equaled one unit of gill net effort). Similar to the spring survey, we used equal amounts of effort in each of the strata, including 0.5 h of electrofishing effort (divided into three, ten-minute runs), four trap nets, and two-paired gill net sets. In total, 12 trap net sets, 6 paired gill net sets, and 1.5 h of electrofishing were utilized during fall of 2018 (Figure 16). Sample locations were selected using the methods identified above. Captured fish and data analysis methods were similar to the spring relative abundance survey (see above).

Otter Trawl Relative Abundance

An otter trawl was used to develop an index of relative abundance for panfish species and to monitor survival from larval production to the beginning of winter. The otter trawl net was 9-m long, 2.2 m wide, 4.8 m high and was rigged with 39 mm stretch mesh in the body, with 13 mm mesh in the cod end. The trawl was outfitted with weighted otter doors to ensure the net remained open while in tow (as described in Hayes et al. 1996). The net had a 15 m bridle, attached to a rope and towed at a speed of 4.0 km/h with a 6.4 m boat equipped with a 175 hp outboard motor. A flow meter was placed at the connection point with the bridle and tow rope to estimate the volume of water sampled. The net was towed at each location for three minutes and Global Positioning Satellite coordinates were recorded at the start and end of each transect. In 2017, 12 sites were randomly selected (four in each strata), using depth profiles and identifying areas with a relatively uniform bottom (e.g. not in areas with large boulders), to sample for an index of relative abundance (Figure 17). Trawling, using the same sites selected in 2017 was conducted on October 22 and October 24, 2018.

Captured fish were identified to species, measured for total length (TL; ± 1 mm), and weighed (±1 g) with a digital scale. In years with high abundance, a subsample of fish were measured and weighed. Fish were processed and released back into the reservoir, when possible. Densities by species were calculated as the number of fish per 100 m^3 for each transect. The mean across all sample locations was calculated to index relative abundance.

Age and Growth

Dorsal fin rays were collected during the spring and fall relative abundance index, spring and fall index creel, and otter trawl surveys described above. Aging structures were collected from up to 5 fish (by species) per 10 mm length interval from sampled fish. Dorsal fin rays were processed and then digitized, using methods described in Butts et al. (2016). Two independent readers estimated fish age. Samples with disagreements in age were revisited and the consensus age was used in further analysis. Age-length keys were generated separately for fish sampled in spring and fall surveys. The age-length keys were used to allocate CPUE from each survey to the proper age-class by species. The age-length keys and length frequency data were used to develop mean length-at-age by season (e.g. spring and fall) for crappies and Yellow Perch.

RESULTS

Angler Catch Rates

Fisheries staff interviewed 296 anglers from 128 individual parties during the spring index creel survey of 2018. Mean party size was 2.3 anglers. The majority of surveyed anglers were residents (96%). Anglers mainly targeted bass (includes both Largemouth Bass and Smallmouth Bass; 36%) in the spring followed by any species (27%; Table 8). Spring anglers expended a total of 1,377 h for a mean of 4.7 h/angler. Total catch for the spring survey was 2,449 fish of which 18% were harvested. Crappies contributed the majority to the harvested fish at 51%. A small proportion of the Smallmouth Bass caught were harvested (5%). Total catch of Bluegill, Largemouth Bass, and hatchery Rainbow Trout was minor (n = 58; Table 9). The mean total length of angler-harvested crappies, Yellow Perch, and Smallmouth Bass collected during the spring index creel were 264, 260, and 344 mm, respectively.

During the fall index creel survey, 97 anglers from 45 individual parties were interviewed. Mean party size was 2.2 anglers. Similar to the spring survey, most anglers were residents (91%). Anglers targeted crappies (28%) most frequently, followed by Smallmouth Bass (27%; Table 8). Anglers fished a total of 570 h for a mean of 5.9 h/angler. Total catch was 3,291 fish of which 60% were harvested. The most commonly harvested species were crappies (95%), Yellow Perch (3%), and Smallmouth Bass (1%). Similar to the spring survey, Smallmouth Bass were released often after capture (Table 10). Total catch of Bluegill, Largemouth Bass, Pumpkinseed *Lepomis gibbosus*, and hatchery Rainbow Trout was minor (n = 107) in the fall survey. Mean length of fall harvested crappies substantially decreased from the spring to 200 mm, but only slightly decreased for Yellow Perch and Smallmouth Bass to 251 and 341 mm, respectively (Figure 18).

Overall, angler catch rates of crappies and Yellow Perch were lower in the spring than fall (Table 9 and Table 10). Catch rates (± 90% CI) for anglers targeting crappies (4.90 f/h ± 5.64), Yellow Perch (0.63 ± 0.77) and Smallmouth Bass (1.61 ± 1.64) were higher than those of average anglers, but were not statistically different. Most anglers (88%) harvested zero to five crappies and/or Yellow Perch/trip; however, 6% of anglers harvested greater than 15 fish/trip (Table 11). Harvested crappies and Yellow Perch observed in the index creel surveys were predominately age-3 (Table 12). Differences were observed between surveys in terms of which age classes contributed to the harvest. Crappies age-1 to age-5 were represented in the spring survey, whereas age-1 to age-4 were represented in fall-harvested fish. Yellow Perch had similar age classes present in the sample ranging from age-2 to age-5 for both seasons.

Crappie harvest ranged from 15 to 23% for the sampling events. Crappies total catch ranged from 19 to 34%. Total one-year crappies harvest and total catch was estimated at 18% and 25%, respectively (Table 13). Yellow Perch harvest ranged from 3 to 29%. Yellow Perch total catch ranged from 3 to 36%. Total one-year Yellow Perch harvest and total catch was estimated at 20% and 24%, respectively (Table 13).

Spring Relative Abundance Index

Crappies were captured using all three gear types during the spring abundance survey and contributed 662 individuals to the total catch. Total CPUE, using three gear types for crappies was 61 f/e. CPUE was highest for crappies using gill nets (27 f/e), followed by electrofishing (21 f/e) and trap nets (13 f/e). Age-1 through age-4 crappies were present in the spring relative abundance survey. CPUE was highest for age-1 crappies (50 f/e), followed by age-2 (5 f/e), age-3 (4 f/e), with the remaining CPUE being age-4 (2 f/e). Catch was highest for crappies in the Bruneau River arm accounting for 55% of the total CPUE, followed by the main pool (36%) and the Snake River arm (9%). Mean W_r was 107 for spring-captured crappies and ranged from 71 to 180. This indicated that most fish had good body condition coming out of the winter months. Mean total length of crappies was 152 mm (Figure 19). PSD for spring-captured crappies was 69 indicating balanced size structure for the population.

Like crappies, Yellow Perch were captured using all three gear types and contributed 582 individuals to the total catch during the spring abundance survey. Total CPUE, using three gear types for Yellow Perch was 49 f/e. Using gill nets resulted in the highest Yellow Perch CPUE (35 f/e); followed by electrofishing (7 f/e) and trap nets (7 f/e). Age-1 through age-5 Yellow Perch were present in the spring relative abundance survey. CPUE was highest for age-3 Yellow Perch (16 f/e), followed by age-1 (13 f/e), and age-2 (9 f/e), age-4 and 5 (5 f/e). CPUE was highest for Yellow Perch in the Bruneau River arm accounting for 44% of the total CPUE, followed by the Snake River arm (43%) and the main pool (13%). Mean W_r was 104 for spring-captured Yellow Perch (greater than 100 mm) and ranged from 54 to 199. This indicated that most fish had good body condition coming out of the winter months. Mean total length of Yellow Perch was 216 mm (Figure 19). PSD for spring-captured Yellow Perch was 66 indicating balanced size structure.

Larval Fish Production

Larval production appeared to be slightly above average in 2018, based on the observed abundance. A total of 50 trawl tows (10 per date) were completed on CJ Strike Reservoir during 2018. The average water volume sampled was 179 m^3/tow. Species composition for samples collected included crappies (95%), Yellow Perch (2%), Bluegill (2%), unknown species (< 1%), and Smallmouth Bass (< 1%). The peak densities of larval crappies were observed on the second sampling event conducted on June 11, 2018. Peak densities of larval crappies ranged from 0.0 (CJ09 and CJ10) to 192.0 fish/100 m^3 (CJ02; Figure 20) in 2018. Peak densities of larval crappies recorded since 2005 have averaged 24 fish/100 m^3 within CJ Strike Reservoir. Peak densities of larval crappies, averaged across all sample sites, in 2018 were 35.4 fish/100 m^3 (Figure 21).

Peak densities of larval Yellow Perch were observed during the first sampling event conducted on June 5, 2018. Peak densities of larval Yellow Perch ranged from 0.0 (CJ05, CJ07, CJ08, CJ09, CJ10) to 5.5 fish/100 m^3 (CJ01). This was the third year peak densities of larval Yellow Perch were identified within the reservoir. Peak densities of larval Yellow Perch, averaged across all sample sites, were 1.2 fish/100 m^3 in the 2018 survey.

CJ Strike Reservoir average ZQI ranged from 0.9 g/tow (October) to a high of 26.3 g/tow (June; Figure 22). The Bruneau River arm consistently had the highest ZPR and ZQI values, followed by the main pool and Snake River arm, respectively.

Fall Relative Abundance Index

Crappies were sampled in higher abundance in the fall than in the spring with 714 crappies captured. Total CPUE, using three gear types for crappies was 94 f/e. Gill nets resulted in the highest crappies CPUE (40 f/e), followed by trap nets (38 f/e) and electrofishing (17 f/e). Age-0 through age-4 crappies were present in the fall relative abundance survey. CPUE was highest for age-1 crappies (82 f/e), followed by age-2 (8 f/e), age-0 (3 f/e), with the remaining CPUE being comprised of age-3 and 4 fish (< 1 f/e). CPUE was highest for crappies in the main pool accounting for 55% of the total CPUE, followed by the Bruneau River arm (28%) and the Snake River arm (17%). Mean W_r was 119 for fall-captured crappies and ranged from 81 to 159. This indicated that most fish had good body condition prior to entering the winter months. Mean total length of crappies was 190 mm (Figure 23). PSD for fall-captured crappies was 36, indicating a skewed size structure towards smaller fish.

Yellow Perch also were observed in higher abundance in the fall than in the spring with 596 individuals captured during the survey. Total CPUE, using three gear types for Yellow Perch was 98. Similar to crappies, gill nets resulted in the highest crappies CPUE (86 f/e), followed by trap nets (6 f/e) and electrofishing (6 f/e). Age-1 through age-5 Yellow Perch were present in the fall relative abundance survey. CPUE was highest for age-2 Yellow Perch (49 f/e), followed by age-1 and 3 (19 f/e), age-4 (10 f/e), and age-5 (< 1 f/e). CPUE was highest for Yellow Perch in the Bruneau River arm accounting for 39% of the total CPUE, followed by the main pool (33%) and the Snake River arm (27%). Mean W_r was 93 for fall-captured Yellow Perch and ranged from 72 to 184. This indicated that most fish had fair to good body condition prior to entering the winter months. Mean total length of crappies was 223 mm (Figure 23). PSD for fall-captured Yellow Perch was 70 indicating a balanced size structure for the population.

Otter Trawl Relative Abundance

In 2018, the use of otter trawl gear was successful in collecting multiple species and age classes. A total of 12 otter trawl tows were completed on CJ Strike Reservoir during 2018 (Figure x). The average water volume sampled was 2,280 m^3/tow. Species composition consisted of crappies (54%), Yellow Perch (30%), and Bluegill (16%). Bluegill were captured at more sites (*n* = 7) than any other species, followed by Yellow Perch (*n* = 6) and crappies (*n* = 4). Densities of panfish species were the highest in the Bruneau River arm, intermediate in the Snake River arm, and the lowest in the main pool (Figure 24). Crappie densities ranged from 0.0 to 3.3 fish/100 m^3. Yellow Perch densities ranged from 0.0 to 0.7 fish/100 m^3. Bluegill densities ranged from 0.0 to 0.4 fish/100 m^3. Mean densities of crappies, Yellow Perch, and Bluegill were 0.29, 0.17, and 0.09 fish/100 m^3, respectively (Figure 25). Length frequencies for crappies and Yellow Perch captured by otter trawl are presented in Figure 26.

Catch of crappies and Yellow Perch decreased from 2017 to 2018, using otter trawl gear. Age-1 crappies were the most abundant age class with a mean density of 0.28 fish/100 m^3 (Figure 27). Ages of crappies represented in otter trawl ranged from age-0 to age-2. Age-0 Yellow Perch were the most abundant Yellow Perch age class sampled by otter trawl with a mean density of

0.06 fish/100 m^3 (Figure 27). Ages of Yellow Perch sampled in otter trawls ranged from age-0 to age-4.

Age and Growth

Age and growth data in 2018 was very similar to that observed in the previous two years. To develop the age-length keys and proportion the CPUE by year class, 297 fish (spring n = 153; fall n = 144) were aged using dorsal fin rays. The age-length keys for spring and fall crappies were developed using 86 and 67 samples, respectively. Age-length keys for spring and fall Yellow Perch were developed using 70 and 74 samples, respectively. Mean length-at-age differed slightly between spring and fall surveys for both crappies and Yellow Perch (Figure 28). The most numerous age class sampled for crappies was age-1 for both seasons. Age-1 crappies were mainly found within the main pool and the Bruneau River arm. The most numerous age class sampled for Yellow Perch in the spring was age-3, while the age-2 age class was dominant in the fall.

DISCUSSION

In 2018, the panfish assessment was continued to increase our knowledge of population dynamics within CJ Strike Reservoir. It was the third year of the assessment and continuation of the angler creel surveys, larval fish production, and the use of otter trawl gear. Spring and fall relative abundance indices and zooplankton quality index surveys were completed for the second year. Aging of dorsal fin rays for crappies and Yellow Perch was also continued to improve our understanding of population age structure and growth rates, as well as understanding how angler harvest impacts specific age classes of these species.

Many of the patterns identified over the past two years continued in 2018, but some changes were also observed. In 2016 and 2017, the number of interviews conducted during each season were nearly equal (Peterson et al. 2018; Cassinelli et al. 2018). However, in 2018, staff completed 75% of the interviews during the spring index. The total number of anglers interviewed increased 34% between 2017 and 2018. The number of anglers targeting Smallmouth Bass increased 70% during 2018. Angler preference towards crappies and Yellow Perch remained similar to previous years. Another noted change between 2018 and the previous two years was the age of harvested crappies and Yellow Perch. Previously, anglers harvested predominately age-4 crappies and Yellow Perch. In 2018, ages of harvested crappies varied much more than previous years. Age-1 crappies were present in the harvest for the first time since initiation of the project. Similar age classes were present for Yellow Perch between years.

Crappies produced in the spring of 2017 (age-1) began recruiting to the fishery during the spring of 2018. Harvest rates increased nearly 18.5 fold between the spring and fall survey, and consisted of mainly age-1 fish. Mean length of harvested crappies also indicated a shift to smaller and younger fish (spring = 264 mm vs. fall = 200 mm). Using data collected in 2016 and 2017, most harvested crappies were greater than 230 mm in total length. If total harvest of crappies were to become an issue at CJ Strike Reservoir, a minimum length limit of 230 mm could be implemented, which would have reduced harvest by up to 33% in 2018. Before implementing such a rule, a comprehensive understanding of harvest, age, growth and mortality data are needed. Additional years of the index creel surveys will help us refine the patterns in angler catch and how these are related to population metrics generated by various sampling gears. These surveys should be continued for three to five more years. This would span the life cycle of both strong and weak year classes currently present in the population and provide a more detailed data to analyze whether harvest restrictions would benefit the fishery.

Differences in frequency of bag were observed between the two previous years and 2018. Similar to past years, the majority of the anglers harvested less than five crappie or Yellow Perch combined. However, due to the abundant 2017 year class of crappies, a 20% increase in the number of anglers that harvested greater than 15 panfish occurred during the fall survey. In 2018, 81% of the harvested panfish, observed on creel dates, were caught by anglers keeping 15 or more panfish. Seven anglers harvested greater than 150 crappie, which lead to the increase in catch rates and numbers of fish harvested. As additional crappies from the abundant 2017 year class grow and recruit into the fishery, observations of larger bag limits will likely become more frequent. Frequency of bag for Yellow Perch were similar between survey years.

In 2018, we continued the current systematic sampling design, using multiple gear types in both the spring and fall, to develop representative indices of crappies and Yellow Perch populations in CJ Strike Reservoir. These surveys were initiated in 2017 (Cassinelli et al. 2018) to establish an age-specific index of crappies and Yellow Perch by relative abundance. This will allow for estimates of mortality and provide a better understanding of gear-specific biases (e.g. size selectivity). Monitoring age-specific relative abundances should enable us to identify population bottlenecks (e.g. overwinter survival for young-of-the-year crappies or Yellow Perch). In the spring and fall, crappies and Yellow Perch were captured at differing rates by gear type, with gill nets producing the highest CPUE. These results were contradictory to previous studies where electrofishing produced higher catch rates for crappies (Butts et al. 2011; Dillon 1989). Based on Dillon (1989), catch rates using the current gear types and methods should allow us to detect changes in the panfish populations through time. The primary objective of the fall relative abundance and otter trawl surveys was to capture smaller and younger panfish than those captured by anglers or in the spring index survey. In 2018, these surveys were successful at indexing age-0 and age-1 crappies and Yellow Perch. CPUE increased between the spring and fall surveys for both species, due to the increased catch of age-0 and 1, similar to 2017 (Cassinelli et al. 2018).

Age-1 crappies dominated the sample for the spring and fall relative abundance surveys and the otter trawl survey in 2018. The year class dominance presents a unique opportunity to follow these crappies through their life cycle to determine important factors such as age at maturity, growth rates, and annual mortality rates (e.g. fishing and natural mortality). Following the year class should also help us identify which sampling techniques work best at different life stages. Therefore, we will continue the current systematic sampling design, using multiple gear types in both the spring and fall to develop representative indices of crappies and Yellow Perch populations in CJ Strike Reservoir.

Relative production of larval crappies has been indexed (by Regional staff) for the past 14 years in CJ Strike Reservoir. Spatial and temporal variation was again observed in the 2018 assessment and suggested sampling should continue across multiple weeks to identify peak larval production. Relative production of larval crappies in 2018 represented a 48% increase from mean peak larval estimates since 2005. The 2018 survey represented the third time larval Yellow Perch have been reported. Larval Yellow Perch decreased in relative abundance between 2017 and 2018 by 48%. Prior surveys indicated mean densities for larval Yellow Perch ranged from 0 to 1.9 fish/100 m^3 (2012 to 2015 unpublished data, IDFG). Densities, in 2018, were similar to densities observed between 2012 and 2015. Monitoring larval crappies and Yellow Perch production will be important to estimating survival of these species at multiple life-stages and should continue.

Length-at-age comparisons for crappies and Yellow Perch between survey years were relatively similar. A more in-depth analysis of growth by year class will be completed with additional years of surveys. Both species continue to exhibit growth throughout the summer as mean length-at-age increased between the spring and fall surveys, similar to 2017 (Cassinelli et al. 2018). Relative weights suggested that most fish had good body condition coming out of the winter and again in the fall prior to entering winter. Since 2016, 907 dorsal fin rays have been processed and aged, of which 479 were crappies and 428 were Yellow Perch. Dorsal fin rays continue to produce quality results that can be used to generate age-length keys to assign individual sampled fish to specific age classes. Growth appears to vary slightly between survey years, but separation (based on mean length-at-age) of year classes is still fairly well defined. Based on current understanding of age and growth for these populations, collecting 5 fish per 10 mm length group should be sufficient to identify age class breaks and overlaps in size structure between year classes.

RECOMMENDATIONS

1. Continue the index creel survey in both the spring and fall and identify angler use patterns, specifically related to panfish populations found in CJ Strike Reservoir.
2. Continue sampling larval production and assess relationships between larval and older age classes using otter trawl density estimates.
3. Continue the systematic sampling protocol for CJ Strike Reservoir using gill nets, trap nets, and electrofishing to develop a representative index of crappies and Yellow Perch populations.
4. Continue collecting age structure data, using dorsal fin rays to develop age-lengths keys. Based on previous data, collect 5 fish per 10 mm length group of each species.

Table 8. Count of anglers (spring and fall), their primary targeted species, and residency collected at CJ Strike Reservoir during the spring and fall index creel surveys in 2018.

Species/Type	Anglers spring	Frequency (%)	Anglers fall	Frequency (%)	Anglers spring and fall combined	Frequency (%)
	Primary targeted species					
Crappies	73	25%	27	28%	100	25%
Yellow Perch	29	10%	13	13%	42	11%
Smallmouth Bass	108	36%	26	27%	134	34%
Rainbow Trout	3	1%	6	6%	9	2%
Channel Catfish	4	1%	-	-	4	1%
Any species	79	27%	25	26%	104	27%
	Residency					
Idaho resident	285	96%	88	91%	373	95%
Non-resident	11	4%	9	9%	20	5%

Table 9. Catch and catch rate (fish/h) estimates collected from anglers during the spring index creel survey at CJ Strike Reservoir in 2018.

Disposition	Bluegill	Crappies	Largemouth Bass	Rainbow Trout	Smallmouth Bass	Yellow Perch
	Number					
Harvest	13	229	0	6	93	97
Release	22	165	8	9	1,679	119
Total catch	35	394	8	15	1,772	216
	CPUE fish/h (± 90% CI)					
Harvest	0.01 (0.02)	0.17 (0.22)	<0.01 (0.00)	<0.01 (0.01)	0.07 (0.09)	0.07 (0.11)
Release	0.02 (0.03)	0.12 (0.17)	0.01 (0.01)	0.01 (0.01)	1.22 (1.40)	0.09 (0.12)
Total catch	0.03 (0.04)	0.29 (0.37)	0.01 (0.01)	0.01 (0.02)	1.29 (1.47)	0.16 (0.22)

Table 10. Catch and catch rate (fish/h) estimates collected from anglers during the fall index creel survey at CJ Strike Reservoir in 2018.

Disposition	Bluegill	Crappies	Largemouth Bass	Rainbow Trout	Smallmouth Bass	Yellow Perch
			Number			
Harvest	9	1,896	1	0	14	66
Release	75	409	20	1	727	72
Total catch	84	2,305	21	1	741	138
			CPUE fish/h (± 90% CI)			
Harvest	0.02 (0.03)	3.32 (4.82)	<0.01 (0.00)	0.00 (0.00)	0.02 (0.04)	0.12 (0.16)
Release	0.13 (0.23)	0.72 (1.02)	0.04 (0.06)	<0.01 (0.00)	1.27 (1.55)	0.13 (0.21)
Total catch	0.15 (0.25)	4.04 (5.67)	0.04 (0.06)	<0.01 (0.00)	1.30 (1.58)	0.24 (0.33)

Table 11. Frequency of harvested crappies and Yellow Perch observed in the creel of interviewed anglers at CJ Strike Reservoir during spring and fall of 2018.

Frequency of bag	Anglers with crappies (spring)	Frequency (%)	Anglers with crappies (fall)	Frequency (%)	Anglers with Yellow Perch (spring)	Frequency (%)	Anglers with Yellow Perch (fall)	Frequency (%)
0 fish	250	84%	62	64%	273	92%	74	76%
1 fish	12	4%	2	2%	10	3%	10	10%
2 fish	7	2%	4	4%	4	1%	4	4%
3 fish	4	1%	0	0%	2	1%	1	1%
4 fish	7	2%	3	3%	0	0%	2	2%
5 fish	2	1%	2	2%	0	0%	3	3%
6 fish	3	1%	0	0%	2	1%	1	1%
7 fish	3	1%	1	1%	0	0%	0	0%
8 fish	1	0%	1	1%	0	0%	2	2%
9 fish	0	0%	0	0%	1	0%	0	0%
10 fish	3	1%	0	0%	1	0%	0	0%
11 fish	0	0%	0	0%	0	0%	0	0%
12 fish	1	0%	0	0%	0	0%	0	0%
13 fish	0	0%	0	0%	1	0%	0	0%
14 fish	1	0%	0	0%	1	0%	0	0%
15 fish	0	0%	1	1%	1	0%	0	0%
> 15 fish	2	1%	21	22%	0	0%	0	0%

Table 12. Estimated age-specific percentage of harvested crappies and Yellow Perch observed in the creel of interviewed anglers at CJ Strike Reservoir during spring and fall of 2018.

Species	Season	Estimated age	Percent of harvest
Crappies	Spring	1	1%
		2	23%
		3	45%
		4	29%
		5	2%
	Fall	1	71%
		2	23%
		3	0%
		4	6%
Yellow Perch	Spring	2	2%
		3	43%
		4	29%
		5	26%
	Fall	2	49%
		3	32%
		4	17%
		5	2%

Table 13. Individual tagging events, locations, sampling gear types, species, number of fish tagged, and number of harvested and released fish used to develop crappies and Yellow Perch (YLP) angler harvest and total catch estimates, presented with 90% confidence bounds. Fish harvested due to the presence of a tag are not included in harvest estimates but are included in total catch estimates. Median days-at-large (dal) are reported for each individual tagging event.

Date	Sample gear	Species	Tags released	Reported harvested	Reported released	Angler harvest (%)	90% CI (%)	Total catch (%)	90% CI (%)	Median dal
5/17/2017	Electrofish	crappies	45	5	0	15.4	15.9	19.3	17.7	134
10/26/2017	Electrofish	crappies	31	6	0	22.4	22.6	33.6	27.1	192
	1 year total	crappies	76	11	0	18.3	13.5	25.1	15.8	181
5/17/2017	Electrofish	YLP	54	1	0	3.2	6.8	3.2	6.8	14
10/26/2017	Electrofish	YLP	98	17	3	28.5	15.1	35.6	16.9	208
	1 year total	YLP	152	18	3	19.5	10.3	24.1	11.5	206

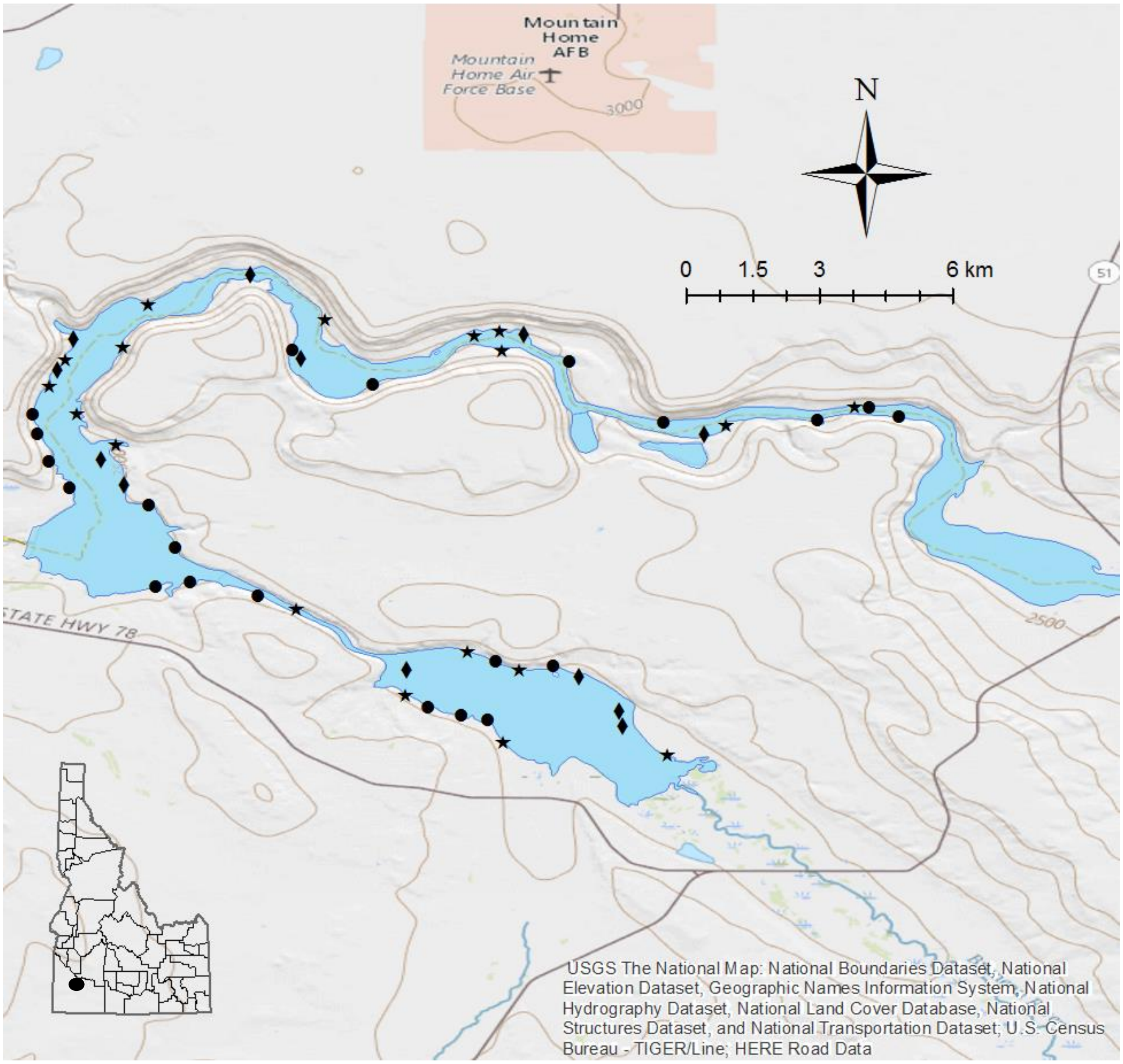


Figure 14. Location of 18 electrofishing (stars), 21 trap net (circles), and 12 gill net (diamonds) sites used to index the relative abundance of crappies, Yellow Perch, and other game and non-game fish populations in CJ Strike Reservoir in spring 2018. GPS coordinates for each surveyed site are presented in Appendix A (WGS 84; decimal degrees).

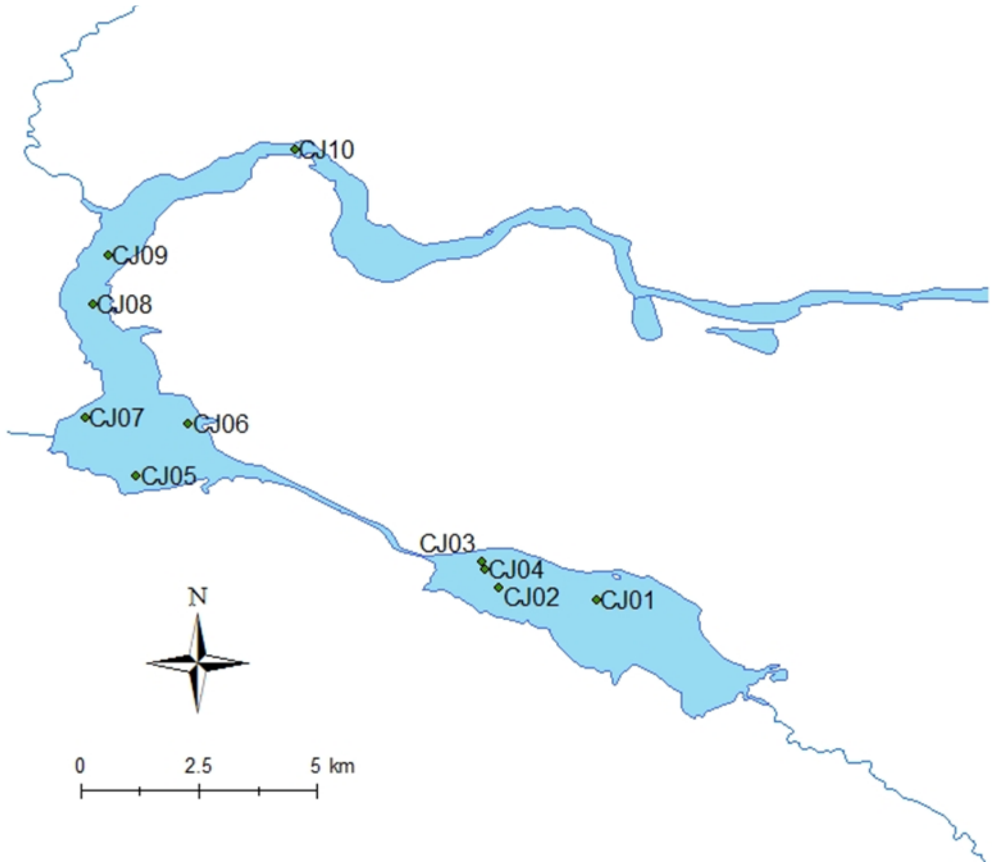


Figure 15. Location of 10 trawl sites used to index the abundance of larval fish in CJ Strike Reservoir from 2005-2018.

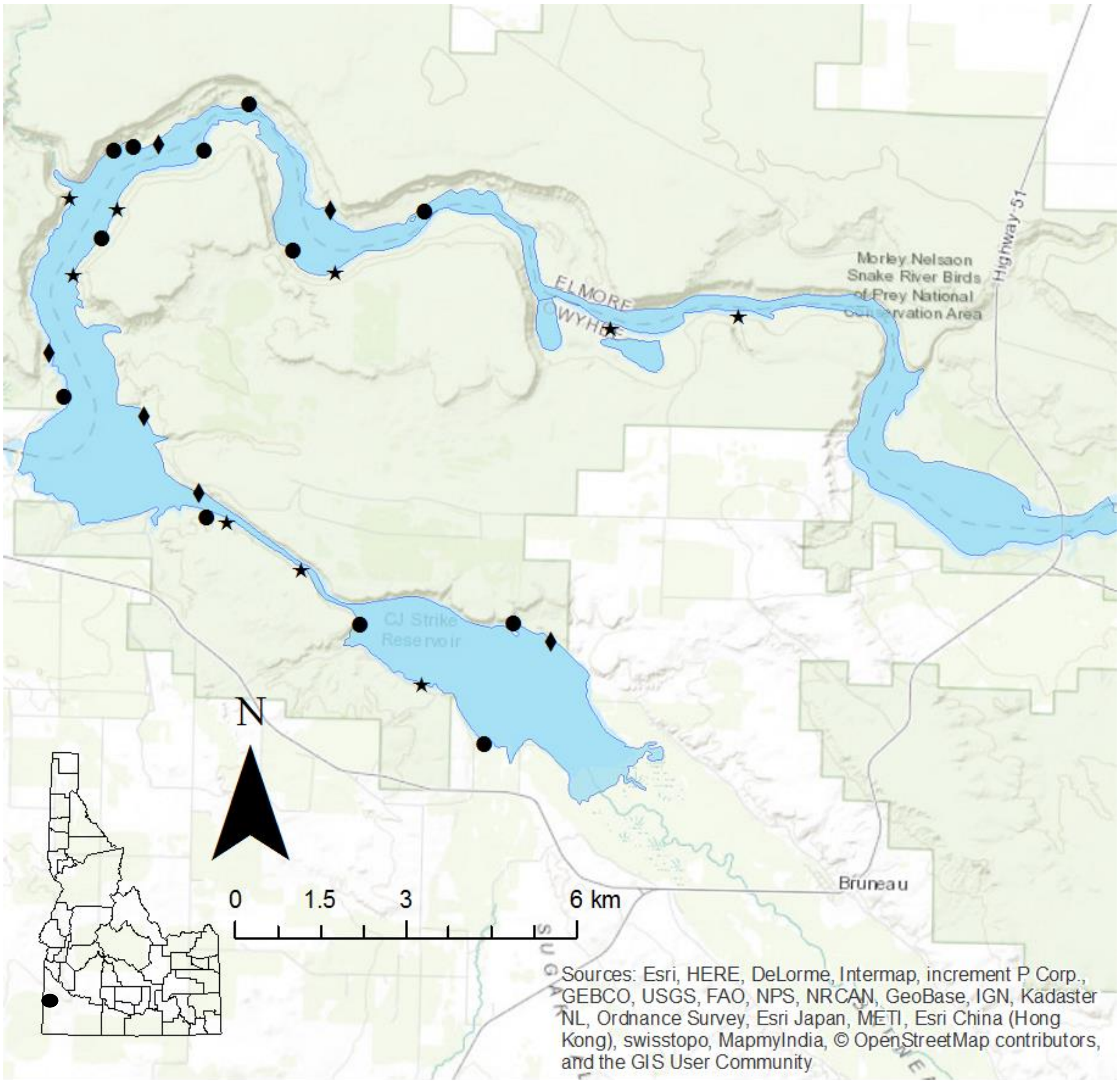


Figure 16. Location of 9 electrofishing (stars), 12 trap net (circles), and 6 gill net (diamonds) sites used to index the relative abundance of crappies and Yellow Perch in CJ Strike Reservoir in fall 2018. GPS coordinates for each surveyed site are presented in Appendix A (WGS 84; latitude and longitude are presented in decimal degrees).

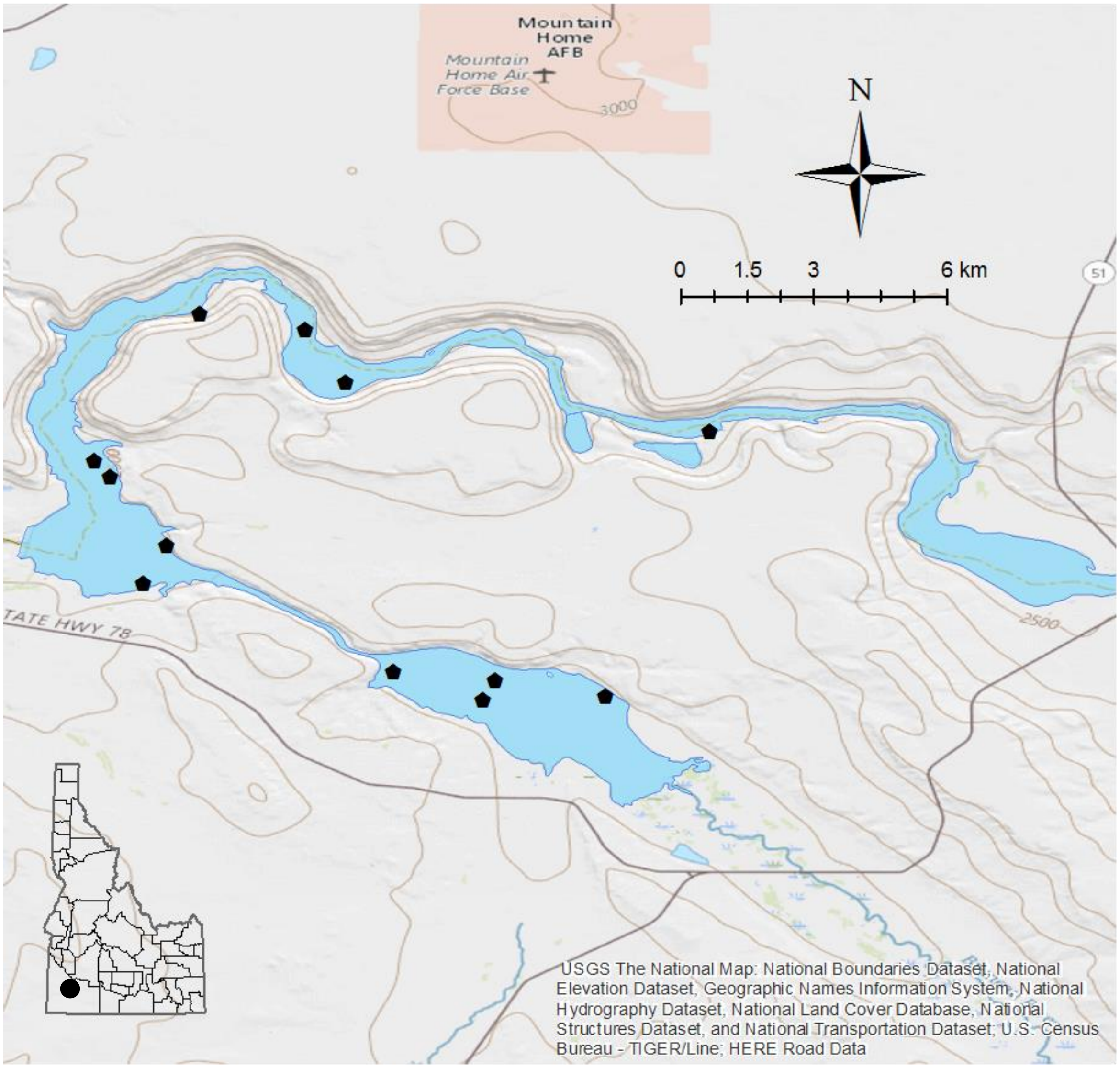


Figure 17. Location of 12 otter trawl sites used to index the abundance of crappies and Yellow Perch, and Bluegill in CJ Strike Reservoir in 2018. GPS coordinates for each surveyed site are presented in Appendix A (WGS 84; latitude and longitude are presented in decimal degrees).

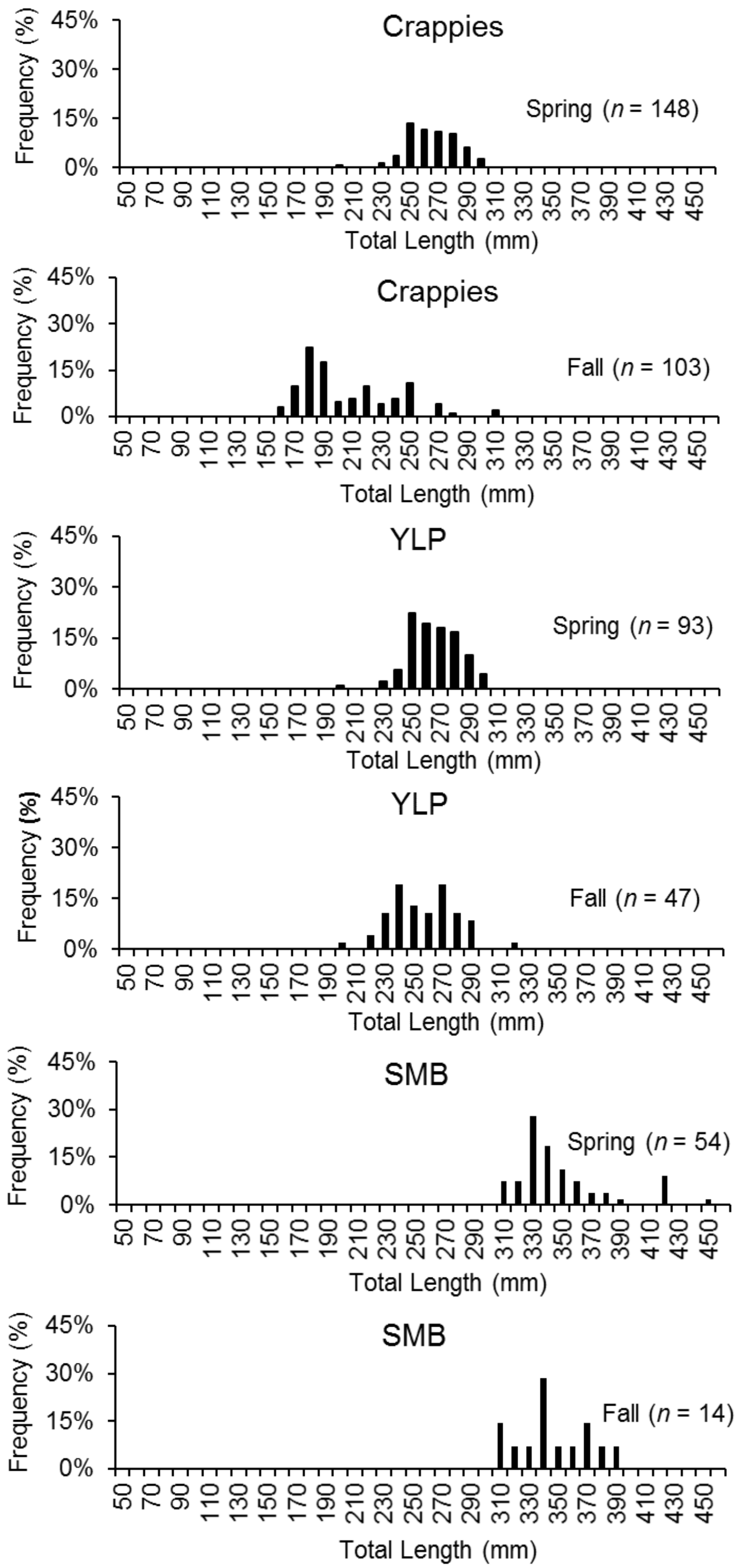


Figure 18. Length-frequency distribution of harvested crappies, Yellow Perch (YLP), and Smallmouth Bass (SMB) sampled during spring and fall index creel surveys in 2018.

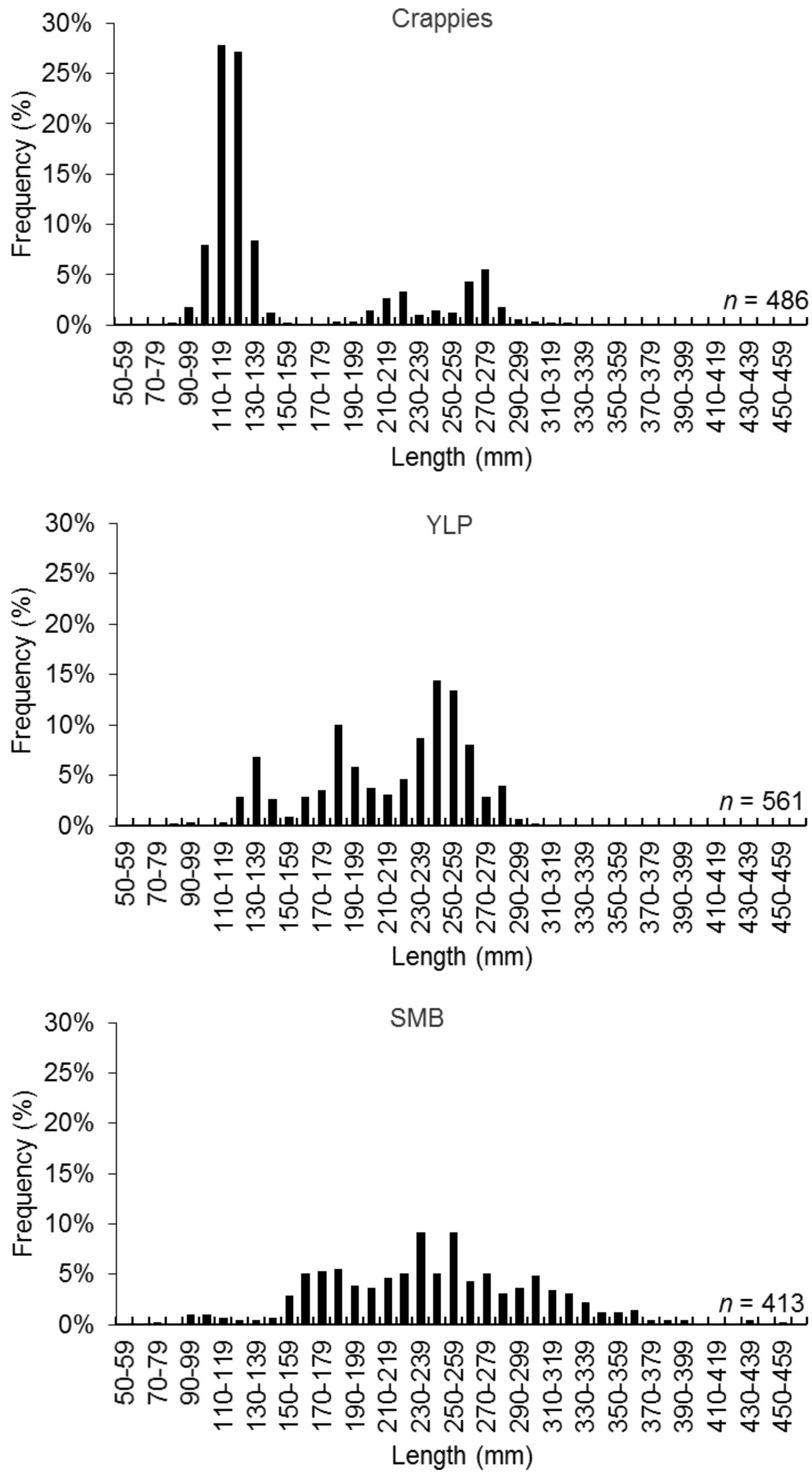


Figure 19. Length-frequency distribution of crappies, Yellow Perch (YLP), and Smallmouth Bass (SMB) sampled during the spring relative abundance survey from CJ Strike Reservoir, in 2018.

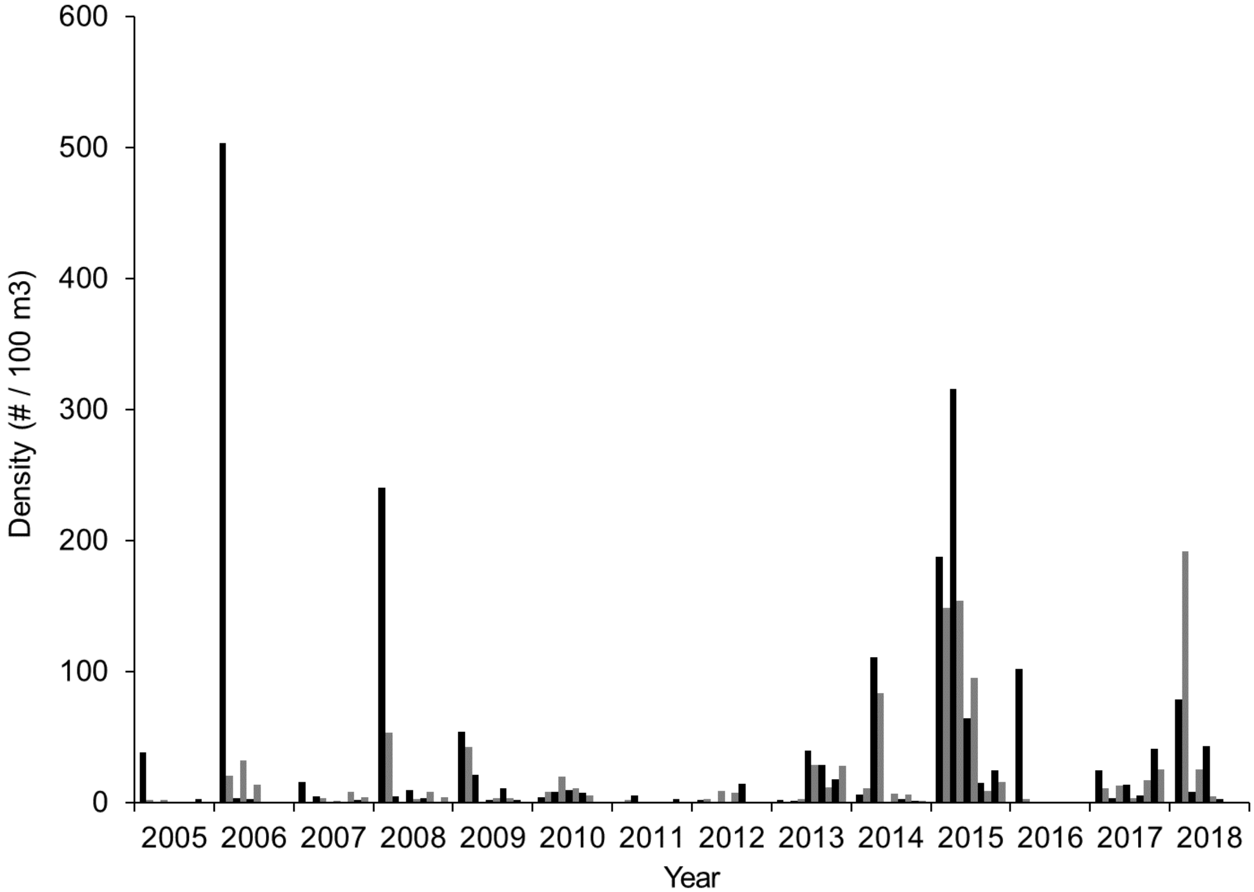


Figure 20. Densities of larval crappies (#/100 m^3) measured in CJ Strike Reservoir from 2005 through 2018. Bars within each year represent 10 individual sites. Sites 1 through 10 are displayed from left to right within each year.

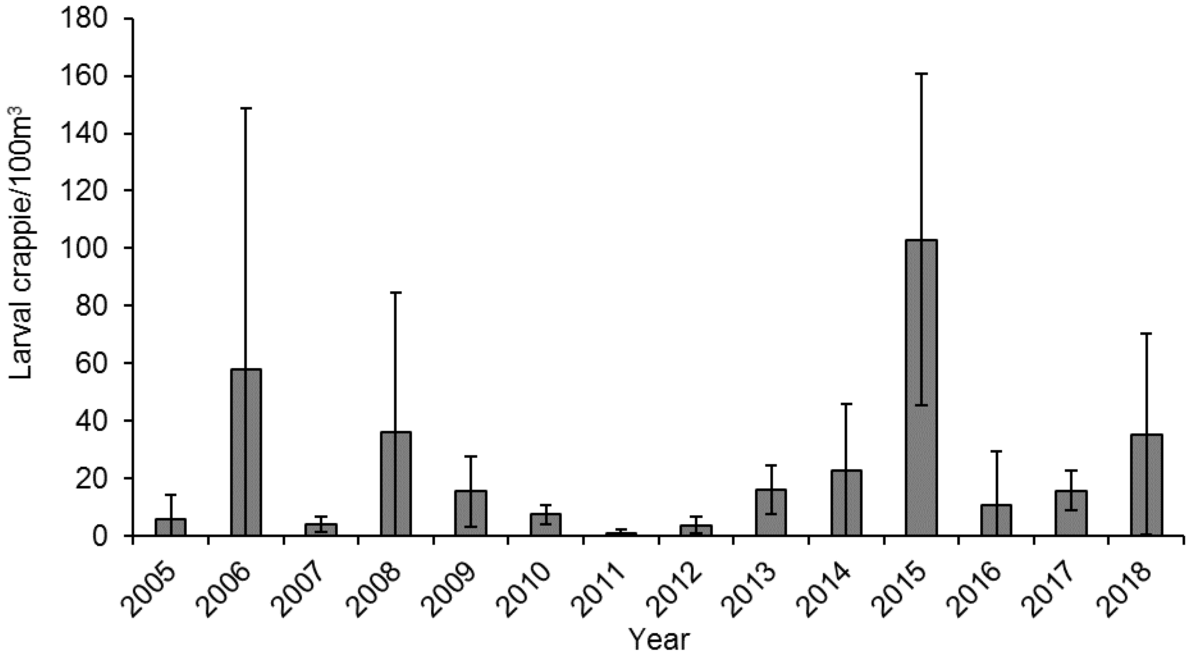


Figure 21. Mean peak densities of larval crappies (averaged across the sample sites) within CJ Strike Reservoir from 2005 to 2018. Error bars represent 90% confidence intervals.

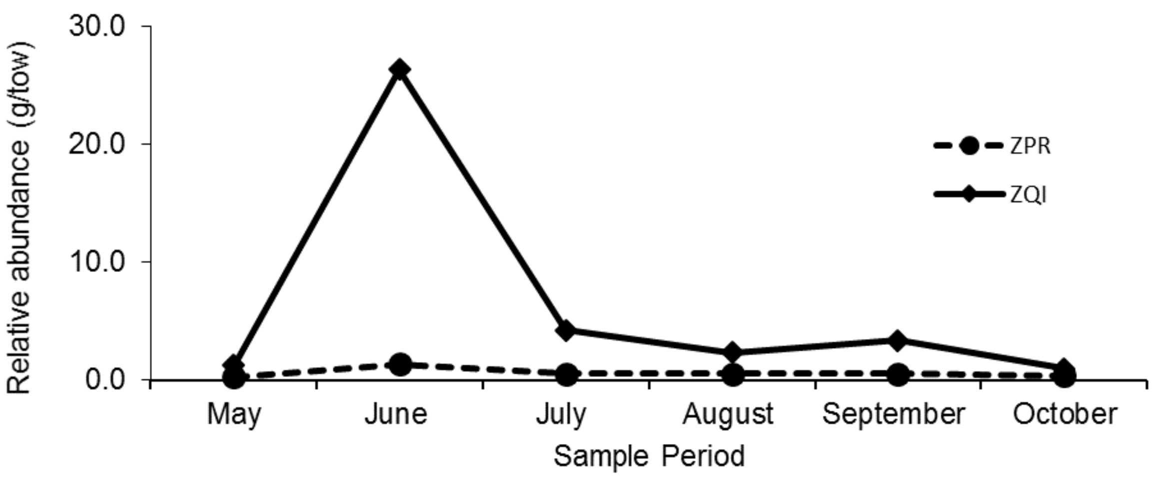
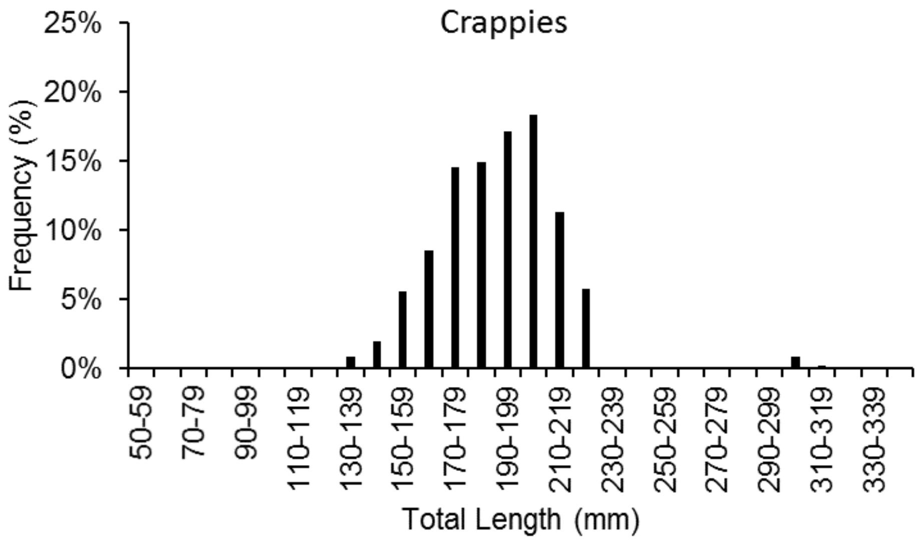


Figure 22. Zooplankton preferred ratio (ZPR) and zooplankton quality index (ZQI) averaged for three sites sampled in CJ Strike Reservoir during 2018.



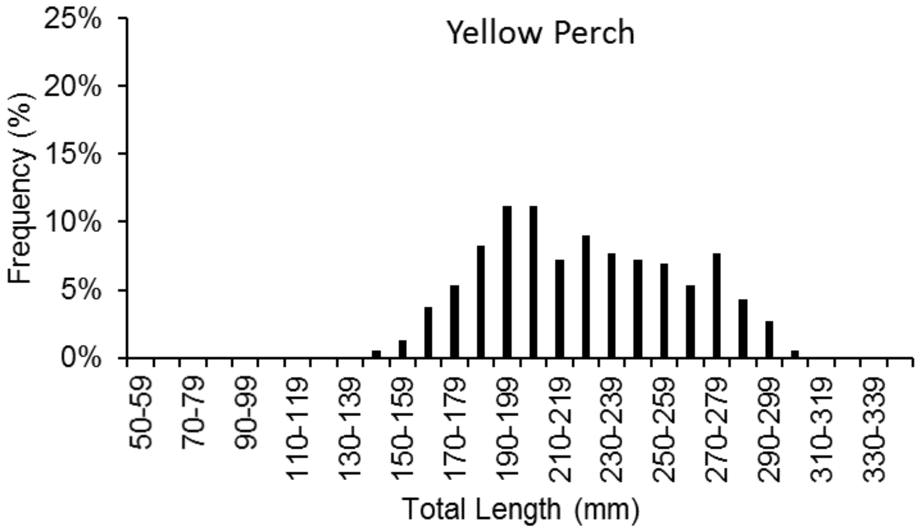


Figure 23. Length-frequency distribution of crappies (*n* = 502) and Yellow Perch (*n* = 376) sampled during the fall relative abundance survey from CJ Strike Reservoir, in 2018.

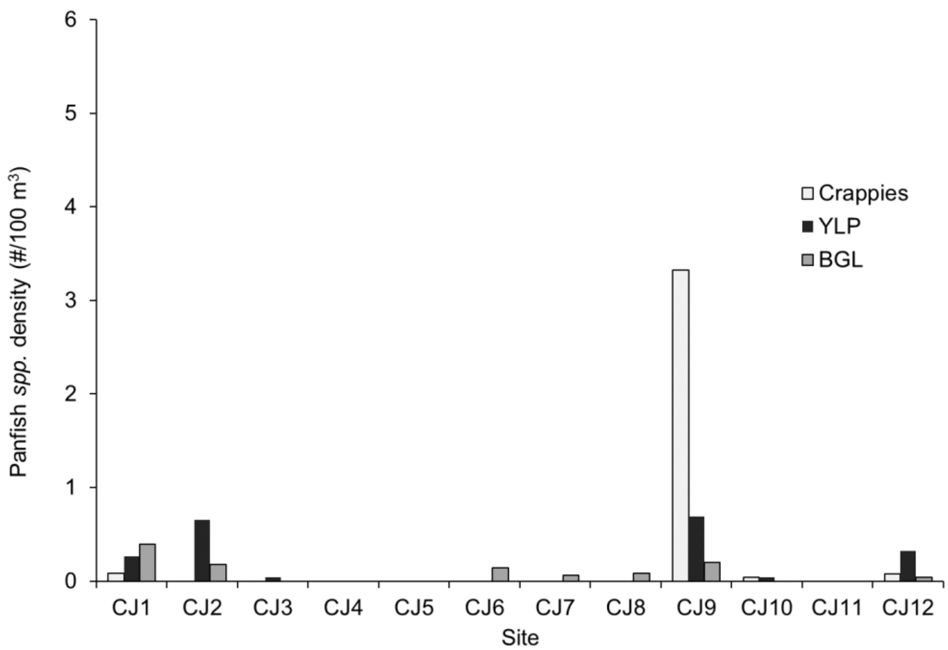


Figure 24. Densities of larval crappies, Yellow Perch, and Bluegill (#/100 m3) in CJ Strike Reservoir from otter trawl sampling in 2018. Sites CJ1-CJ4 were located in the Snake River segment, CJ5-CJ8 the main pool (near the dam), and sites CJ9-CJ12 were located in the Bruneau River segment.

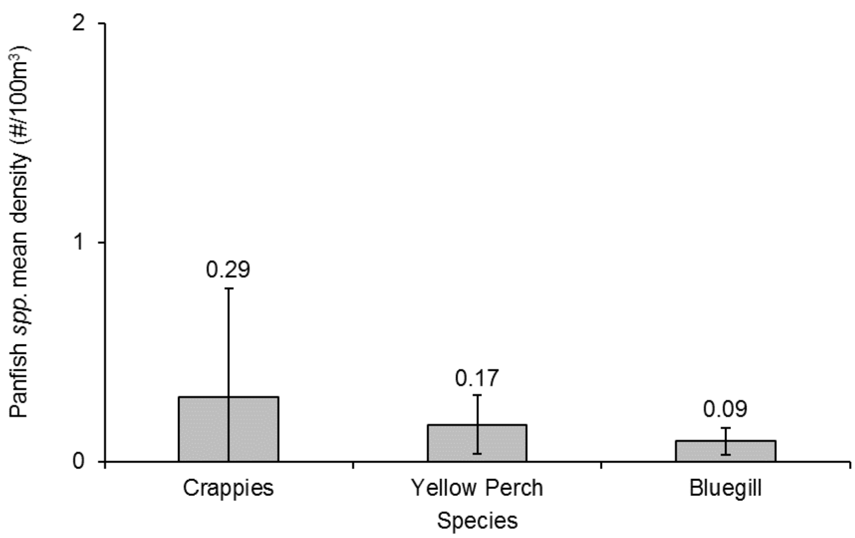


Figure 25. Mean densities of crappies, Yellow Perch, and Bluegill (#/100 m^3) measured using otter trawl in CJ Strike Reservoir during 2018. Error bars represent 90% confidence intervals.

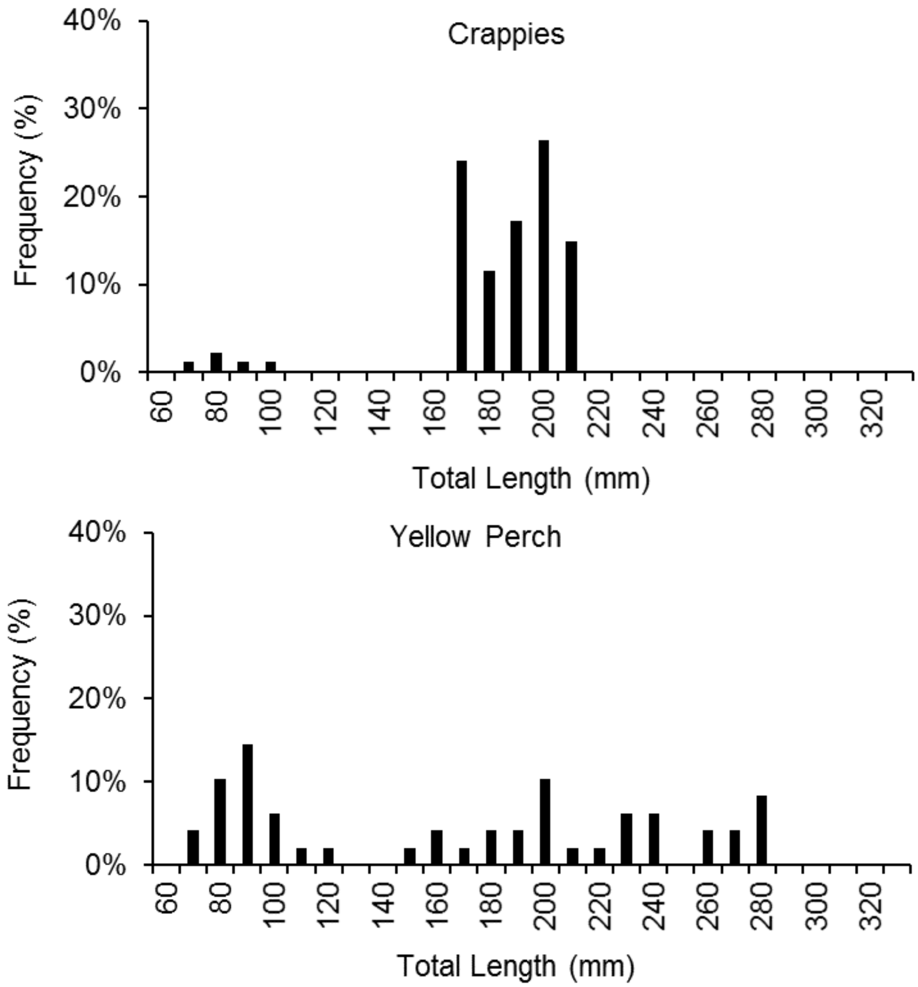


Figure 26. Length-frequency distribution of crappies (n = 87) and Yellow Perch (n = 48) sampled using otter trawl during the fall of 2018 in CJ Strike Reservoir.

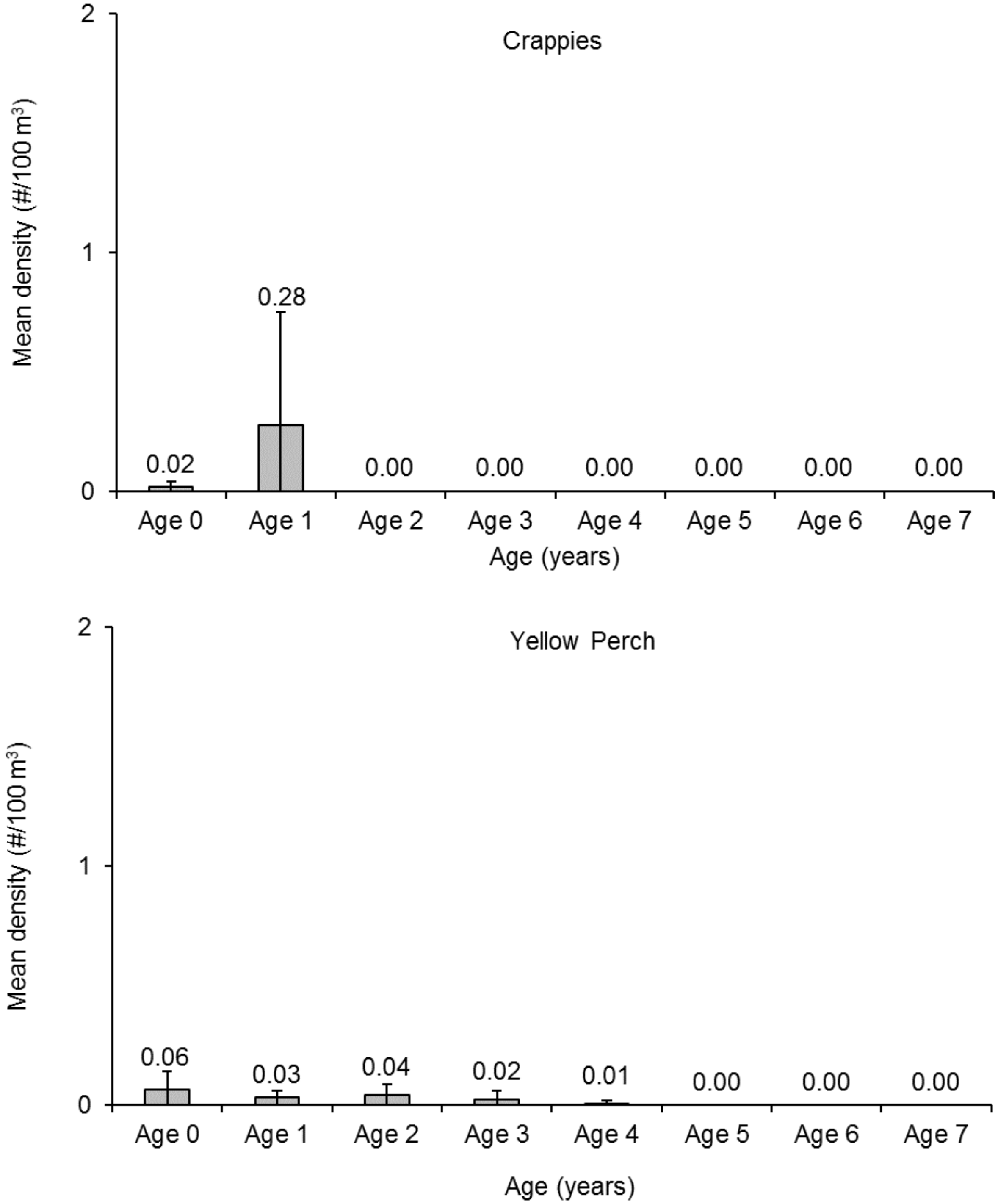
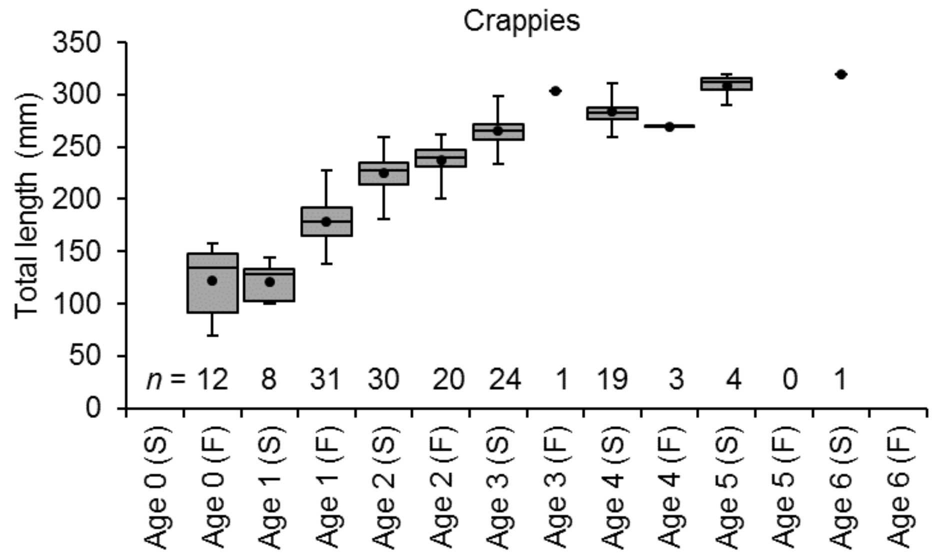


Figure 27. Mean densities of crappies (upper panel) and Yellow Perch (lower panel) densities (#/100 m^3) by each age-class collected using otter trawl in CJ Strike Reservoir during 2018. Error bars represent 90% confidence intervals.



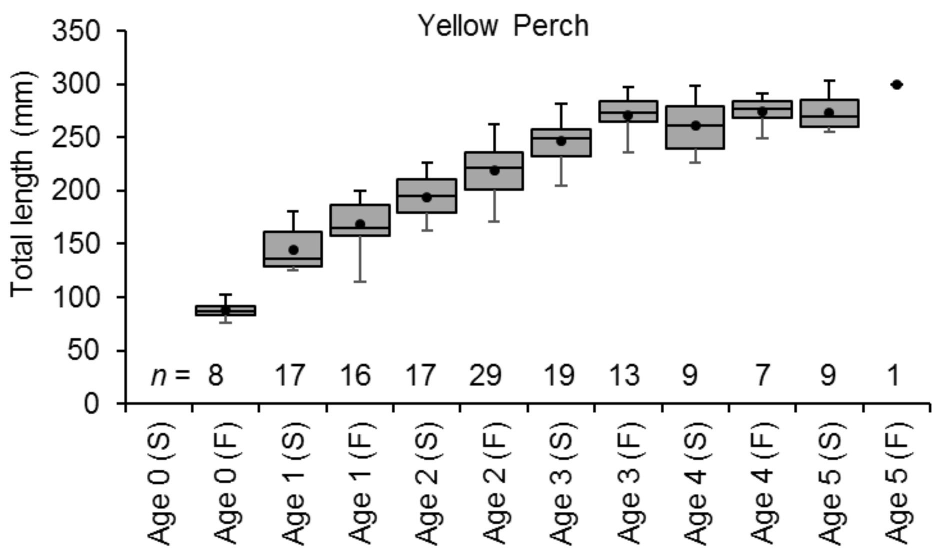


Figure 28. Mean length-at-age shown for crappies and Yellow Perch collected in surveys conducted in the spring (S) and fall (F) of 2018 at CJ Strike Reservoir. The bottom and top of the grey box represents the first and third quartile, respectively. The bars represent the minimum and maximum total length observed. The black circle represents the mean length-at-age for the species at each age.

USE OF PESTICIDES TO CONTROL NUISANCE AQUATIC PLANTS IN SMALL WATERS

ABSTRACT

Excessive aquatic plant growth in Duff Lane and Payette Greenbelt ponds was hampering fishing opportunities. In order to maintain fishing opportunity, we treated portions of these waters with aquatic herbicide (Navigate®, a granular 2, 4-D) at an application rate of 150 lb/acre (168 kg/ha). Submerged aquatic plant abundance was reduced by late summer. Effective long-term weed management will require vigilance and finding a balance between aquatic plant eradication and maintaining adequate amounts and types of aquatic plants for invertebrates and as cover for fish.

Author:

Joseph R. Kozfkay
Southwest Regional Fisheries Manager

INTRODUCTION

Idaho Department of Fish and Game's (IDFG) Southwest Region manages fisheries in about 50 publicly-accessible small ponds and reservoirs. These waters receive significant fishing effort and are an important resource for providing family-friendly opportunities. In some ponds, excess aquatic plant growth and coverage especially during the summer months may limit access or in extreme cases may totally preclude fishing. Furthermore, excess plant growth may create other problems such as high oxygen demand during decomposition, or excessive cover for juvenile fish, leading to high abundances and small sizes. Excessive plant coverage was reducing fishing opportunities in Duff Lane (2.2 ha) and Payette Greenbelt (2.2 ha) ponds. Northern Watermilfoil *Myriophyllum sibiricum* was the predominant species present. Staff treated these waters with herbicide to reduce nuisance plant abundance and biomass.

METHODS

For aquatic plant management, we selected Navigate, a granular 2, 4 D, to treat these ponds, based on past efficacy and low fish toxicity. The recommended application rate for Northern Watermilfoil was 150 lb/surface acre (168 kg/ha). We used Geographic Information Systems (ArcView version 11) to estimate surface acreage. Herbicide was applied using a granular fertilizer spreader mounted to the front of a small boat that was powered with an electric motor. On May 29, 2018, we treated approximately half of Duff Lane and Payette Greenbelt ponds with 550 and 450 lbs of Navigate, respectively.

RESULTS AND DISCUSSION

Herbicide treatment was effective during 2018. Based on visual estimates, > 95% of rooted submerged vegetation was killed. No significant plant re-growth occurred at these ponds prior to fall. Continued effective aquatic plant management will require vigilance and finding a balance between plant eradication and maintaining aquatic plants for invertebrates and as cover for fish.

RECOMMENDATIONS

1. Monitor plant mortality and re-growth in ponds treated during recent years. Apply herbicide or stock Grass Carp on a semi-annual basis or as needed.
2. Monitor aquatic plant coverage in other waters that have a tendency to possess nuisance levels and initiate treatments where necessary.

WARMWATER FISH TRANSFERS TO REGIONAL WATERS

ABSTRACT

Southwest region personnel transferred two species of warmwater fish into 11 waters, during 2018, as a means to re-establish populations and bolster catch rates in existing fisheries. Supplemented waters included several community fishing ponds, Black Canyon Reservoir and the lower Payette River. We utilized boat electrofishing to capture fish for transfer. We transferred 1,589 fish, including of 339 Channel Catfish *Ictalurus punctatus* and 1,250 Smallmouth Bass *Micropterus dolomieu*.

Author:

Michael P. Peterson
Regional Fishery Biologist

INTRODUCTION

The Southwest Region contains 44 small public community-fishing ponds as well as nearly 40 lowland reservoirs. These ponds and reservoirs offer a variety of angling options for both hatchery Rainbow Trout and several warmwater species. Nampa Hatchery regularly supplies Rainbow Trout to many of the community-fishing ponds and lowland reservoirs. However, warmwater fish populations are perpetuated by either natural reproduction or transfers from other waters. Idaho Department of Fish and Game (IDFG) seeks to maintain adequate populations of warmwater fish in many of these community ponds and reservoirs for recreational angling. In 2018, annual transfers of adult Channel Catfish to community fishing ponds were continued to provide put and take fishing opportunities.

In addition to community ponds, we also transferred smallmouth bass in 2018 to re-establish a declining population in the lower Payette River. In winter of 2012/2013, the Bureau of Reclamation drew Black Canyon Reservoir down to complete a geological survey at the dam site. The drawdown transported a large but unquantified amount of sediment through the dam into the lower Payette River. Ultimately, these sediments and high turbidity caused high mortality for several fish species within the reach. While subsequent survey results indicated that relative abundance for several species had returned to levels observed in 2009 (Butts et al. 2011), Smallmouth Bass *Micropterus dolomieu* continued to decline (see Lower Payette River Fish Population Survey within this report). Smallmouth Bass translocations occurred in the lower Payette River and Black Canyon Reservoir during 2018 to hasten population recovery and re-establish a viable fishery.

OBJECTIVES

1. Provide Channel Catfish fishing opportunities in community ponds.
2. Re-establish Smallmouth Bass populations in Black Canyon Reservoir and the lower Payette River, downstream of Black Canyon Dam.

METHODS

Boat electrofishing equipment was utilized to capture warmwater fish for transfer to local waters in 2018. Sources included the public waters of CJ Strike Reservoir and the Snake River from Fort Boise Wildlife Management Area to Payette, ID. Crews collected fish between June 5 and October 5, 2018 using an electrofishing boat equipped with a Midwest Lake Electrofishing Systems (MLES) Infinity system. The MLES unit was set at a 20% duty cycle and a 6,500-watt Honda generator produced approximately 2,200-2,800 watts of pulsed DC power. Dip nets were used to capture stunned fish which were transferred to live cars and held until sufficient numbers were captured to fill a transport truck or trailer. Once loaded, fish were transported by truck using supplemental oxygen at 1.5-2 liters/minute and transferred to release locations.

RESULTS AND DISCUSSION

During 2018, we captured and transferred 1,589 fish including 339 Channel Catfish and 1,250 Smallmouth Bass (Table 14). Releases occurred in nine community ponds, Black Canyon Reservoir, and the lower Payette River in the Southwest Region (Table 14). Smallmouth Bass collections occurred at night in CJ Strike Reservoir. The Smallmouth Bass population found in CJ Strike Reservoir has increased 78% since 2009 (Cassinelli et al. 2018) and remains a viable source for additional translocations within the region. Re-establishing a sustainable population in the lower Payette River may require supplementary releases of Smallmouth Bass. Additional surveys within the reach, in three to five years, will determine if further releases are necessary. Channel Catfish were transferred into nine community-fishing ponds located within the Southwest Region. Channel Catfish have been collected and transferred annually since 2008 (Kozfkay et al. 2010) and transfers should be continued. Channel Catfish transfers provide an additional sportfish opportunity at local community ponds during the summer months after suspending trout stocking because of warm water conditions.

RECOMMENDATIONS

1. Continue to monitor Smallmouth Bass relative abundance in the lower Payette River, every three to five years, to determine if additional releases are necessary to re-establish sustainable populations.
2. Continue transferring Channel Catfish to community fishing waters annually.

Table 14. Summary of Channel Catfish (CAT) and Smallmouth Bass (SMB) capture and transfer efforts to Southwest Region waters during 2018.

Date stocked	Collection method	Collecting water	Receiving water	Species	Number	Mean weight (g)	Mean length (mm)	Release temp (°C)
6/5	Electrofishing	Snake River	Ed's Pond	CAT	25	1814	-	28.3
6/5	Electrofishing	Snake River	Sawyer's Pond	CAT	53	1814	-	24.4
6/5	Electrofishing	Snake River	Horseshoe Bend Mill Pond	CAT	50	1814	-	20.6
6/6	Electrofishing	Snake River	Settlers Pond	CAT	15	1814	-	28.3
6/6	Electrofishing	Snake River	Parkcenter Pond	CAT	56	1814	-	27.8
6/6	Electrofishing	Snake River	McDevitt Pond	CAT	25	1814	-	25.0
6/6	Electrofishing	Snake River	Riverside Pond	CAT	40	1814	-	25.6
6/7	Electrofishing	Snake River	Caldwell Rotary #1 Pond	CAT	50	1814	-	25.0
6/7	Electrofishing	Snake River	Caldwell Gun Club #2 Pond	CAT	25	1814	-	25.0
6/28	Electrofishing	CJ Strike Reservoir	Black Canyon Reservoir	SMB	250	242	263	20.0
8/22	Electrofishing	CJ Strike Reservoir	Lower Payette River	SMB	250	127	215	19.5
9/27	Electrofishing	CJ Strike Reservoir	Lower Payette River	SMB	250	137	220	19.0
10/3	Electrofishing	CJ Strike Reservoir	Lower Payette River	SMB	350	129	216	18.0
10/5	Electrofishing	CJ Strike Reservoir	Lower Payette River	SMB	150	118	210	17.3

2018 ALPINE LAKE SURVEYS

ABSTRACT

Idaho Department of Fish and Game (IDFG) staff from the Southwest Region surveyed 16 alpine lakes during July-August 2018. Sampling efforts focused on headwater portions of the South Fork Payette River near Grandjean, Idaho within the Goat Creek drainage. The majority of the lakes had either never been surveyed, or had not been surveyed recently by IDFG. Data were collected at each lake or site and described fish and amphibian populations, habitat, as well as human use patterns. If historical data was available, populations were assessed relative to stocking history and previously-collected data.

Author:

Joseph R. Kozfkay
Regional Fisheries Manager

OBJECTIVES

1. Describe the distribution, relative abundance, and species composition of fish and amphibian populations at alpine lakes in the Southwest Region.
2. Adjust trout stocking where appropriate to use hatchery resources efficiently and minimize impacts to native fauna while preserving fishing opportunity where practical.

METHODS

Alpine lakes were surveyed July 31 and August 1, 2018 within the South Fork Payette Hydrologic Unit Code (HUC) 4 and the Headwaters South Fork Payette River HUC5. More specifically, we sampled one HUC6: Goat Creek – South Fork Payette River. We visited 16 sampling sites (i.e. polygons on Idaho Department of Fish and Game (IDFG) hydrography layer that we expected to be lentic habitats; hereafter lakes; Figure 29). Lakes were chosen because they either had never been sampled, or had not been sampled within the last ten years. At each lake, we assessed fish and amphibian presence/absence, human use, and basic fish habitat characteristics. Unless fish were observed, no angling surveys occurred in shallow lakes and ponds without suitable fish habitat. In lakes with suitable depths or that had been previously stocked, fish were sampled with hook/line angling, gill nets, or both to collect fish and determine species, total length (TL, mm), and weight (g) information. Gill nets were floating experimental nets, measuring 46 m long by 1.5 m deep, with 19, 25, 30, 33, 38, and 48 mm bar mesh panels. Preferably, nets were set in the evening, perpendicular to shore, and fished overnight. Nets were pulled the following morning or as soon as possible thereafter. In some instances, we soaked gill nets for shorter time periods during the day.

Habitat surveys assessed limnological and morphological characteristics of lake, tributaries, and outlets. Lake length and width were measured using a laser rangefinder (Bushnell yardage-Pro). Mean depth was calculated from nine depth measurements recorded at three equally-spaced cross-sectional transects, using a hand-held sonar device (Strikemaster Polar Vision). Maximum depth was estimated as the greatest depth observed during these measurements. Surface water temperatures were recorded along the lake shore at one point. A visual assessment of salmonid spawning habitat availability was conducted at each lake and its inlets and outlets. Salmonid spawning habitat quality was qualitatively described based on substrate size, flow, and gradient.

Amphibian surveys were conducted by walking the perimeter of each lake and visually inspecting shoreline and near-shore habitats, including areas under logs and rocks. We recorded the species, number, and life stage of all amphibians encountered. Life stages were classified as adult, juvenile, larvae, or egg.

Human use was evaluated based on general appearance of use, number and condition of campsite, number of fire rings, access trail conditions, trail distance, trail difficulty, and presence of litter. General levels of human use were categorized by IDFG staff as rare, low, moderate, and high, based on an overall assessment of the factors described above.

RESULTS AND DISCUSSION

Sixteen lakes were surveyed in the Goat Creek – South Fork Payette River HUC6. All polygon's identified on IDFG's hydrologic layer as putative lakes contained water. Of these, no fish or amphibians were sampled in two lakes, while both were sampled in four lakes. Only fish and only amphibians were sampled in four and six lakes, respectively (Table 15 and 16). The Goat Creek drainage lacks an access trail and is closed to pack animals, and subsequently, evidence of human use was very rare.

Analysis of IDFG's stocking database indicated at least six of these 16 lakes had been stocked historically. Cony Lake (3.4 ha) has been stocked 17 times since 1973, primarily with Cutthroat Trout *Oncorhynchus clarkia* (unknown subspecies). Recently, the stocking request has been 500 triploid Kamloops Rainbow Trout *O. mykiss* (147 fry/ha) at three-year intervals. Sampling resulted in hook and line CPUE of 5 fish/h. Mean length was 363 mm. Fish condition was visually classified as average; and current densities should be maintained. The catch included nine Rainbow Trout and one hybrid *O. clarkii x O. mykiss*, indicating that past stocking of fertile Cutthroat Trout did not result in a self-sustaining population or the lake is susceptible to occasional winter kills. Previous sampling in 1994 resulted in catch of 13 Cutthroat Trout ranging in length from 270 to 342 mm (Allen et al. 2000). Both sampling efforts provide information that suggested stocking was needed to maintain this fishery.

Limber Lake (1.3 ha) has been stocked 18 times since 1973, primarily with Cutthroat Trout. Recently, the stocking request has been for 500 triploid Kamloops Rainbow Trout (385 fry/hectare) at three-year intervals. Sampling resulted in hook and line CPUE of 0.75 fish/h. Mean length was 228 mm. All fish sampled were Cutthroat Trout, indicating that past stocking established a self-sustaining population; however, trout densities were low. Recent stocking does not appear to be contributing though sample sizes were low, so definitively assessing the utility of stocking was difficult. Previous sampling during 1994 resulted in catch of 16 Cutthroat Trout ranging in length from 175 to 302 mm. Stocking should continue to maintain this fishery, though limited sample size during 2018 prevented a definite conclusion regarding the effectiveness of recent stocking efforts.

McWillards Lake (0.9 ha) has been stocked 18 times since 1973, primarily with Cutthroat Trout. Recently, the stocking request has been for 500 triploid Kamloops Rainbow Trout (555 fry/ha) at three-year intervals. No sampling effort was completed as no fish or activity were observed. McWillards Lake is not ideal fish habitat. Survival is likely low due to shallow average and maximum depth, so the lake may be susceptible to periodic winter kill. Surprisingly, Cutthroat Trout (CPUE = 5.14 fish/h; n = 6; mean length = 246 mm) were sampled at the nearest lake downstream (WaterID 14070; 0.3 ha). The origin of this population is unclear as no stocking records exist for it. Stocking records prior to 1973 are incomplete, so it may have been stocked purposefully and not documented or may have been mistaken for McWillards Lake. Alternatively, stocked trout may have emigrated from McWillards Lake and created a self-sustaining population. Past sampling during 1994 resulted in the catch of 15 Cutthroat Trout ranging from 167 to 322 mm. This observation is contradictory to 2018 observations. Because of this conflicting information and uncertainty, stocking should continue until additional sampling efforts are completed.

Oreamnos Lake (4.1 ha) has been stocked 18 times since 1973, primarily with Cutthroat Trout. Recently, the stocking request has been for 500 triploid Kamloops Rainbow Trout (122 fry/ha) at three-year intervals. Sampling resulted in hook and line CPUE of 60 fish/h, indicating very high trout densities. Mean length was 173 mm. All fish sampled were Cutthroat Trout indicating that past stocking established a self-sustaining population. During 1994, twenty-three Cutthroat Trout were sampled with length ranging from 141 to 355 mm. Recent fish stocking does not appear to be contributing to the fishery and should be discontinued.

Packrat Lake (4.5 ha) has been stocked 18 times since 1973, primarily with Cutthroat Trout. Recently, the stocking request has been for 500 triploid Kamloops Rainbow Trout (111 fry/ha) at three-year intervals. Sampling resulted in hook and line CPUE of 14 fish/h, indicating high trout densities. Mean length was 278 mm. All fish sampled were Cutthroat Trout indicating that past stocking established a self-sustaining population. This result is consistent with observation of high angler catches and natural reproduction during 1994 survey efforts. Recent fish stocking does not appear to be contributing to the fishery and should be discontinued.

Three Lake (8 ha) has been stocked 10 times since 1973 including with Cutthroat Trout, hybrids, and Artic Grayling *Thymallus arcticus*. No stocking has occurred since 1996. Sampling resulted in hook and line CPUE of 10 fish/h, indicating high trout densities. Mean length was 229 mm. Brook trout (70%) and Cutthroat Trout (30%) composed the sample. Similarly, during 1994, Brook Trout (54%) and Cutthroat Trout (46%) composed the sample. It is likely that Brook Trout were stocked prior to 1973 as Brook Trout stocking doesn't appear in the stocking database, and historical records are incomplete. The current management approach (no stocking) is appropriate and should continue unless winter kills are documented.

Multiple life stages of Long-toed Salamander *Ambystoma macrodactylum* were observed in or near three lakes (Table 15). In contrast, only adult Columbia Spotted Frog *Rana luteiventris* was observed. Columbia Spotted Frog were observed at 9 of the 16 lakes but generally at relatively low numbers, with the exception of nine adults at Water ID# 14081.

RECOMMENDATIONS

1. Discontinue scheduled stockings in Oreamnos and Packrat lakes unless winterkills are noted. Rainbow Trout have been stocked for at least three, three-year intervals with no indication of contribution to these fish populations. Furthermore, natural reproduction in these lakes is adequate to support fisheries.

Table 15. Number and species of herpetofauna sampled during 2018 lake surveys in the headwaters of Goat Creek a tributary to the upper South Fork Payette River. Herpetofauna are abbreviated as follows: Long-toed Salamander (LTS) and Columbia Spotted Frog (CSF).

LLID	Water ID	Lake Name	Perimeter surveyed (%)	Species	Adults	Juveniles	Larvae
1150480440562	14083	Goat Creek Lake #10	40				
1150510440581	14072	Goat Creek Lake #09	90				
1150540440486	14110	14110	100	LTS			15
1150546440455	14120	Packrat Lake	100	CSF	1		
1150633440570	14076	McWillards Lake	50	CSF	1	0	0
1150638440585	14070	14070	100				
1150688440542	14092	Oreamnos Lake	60	CSF	1		
1150688440542	14092	Oreamnos Lake	60	LTS	4	10	
1150698440454	14123	Limber Lake	100				
1150736440502	14104	Three Lake	35				
1150739440515	66640	66640	100	CSF	1		
1150739440515	66640	66640	100	LTS	6		
1150741440523	14102	14102	100	CSF	3		
1150748440525	14100	14100	100	CSF	1		
1150760440570	14078	14078	100	CSF	1		
1150774440564	14081	Meadow Lake	75	CSF	9		
1150834440614	14062	Cony Lake	60				
Unmapped	Unmapped	Unmapped	100	CSF	5		

Table 16. LLID, Water ID, Lake Name, and hook-and-line sampling information from surveys completed during 2018 in alpine lakes of the Goat Creek drainage, a tributary to the upper South Fork Payette River. Trout species are abbreviated as follows: Brook Trout (BKT) unknown varieties of Cutthroat Trout (CUT), Rainbow x Cutthroat Trout hybrids (HYB), and Rainbow Trout (RBT).

LLID	Water ID	Lake Name	Species	Catch	Effort (h)	CPUE (fish/h)	Mean Length (mm)	Min Length (mm)	Max Length (mm)
1150546440455	14120	Packrat Lake	CUT	15	1.08	13.80	278	150	375
1150638440585	14070	14070	CUT	6	1.17	5.10	246	220	265
1150688440542	14092	Oreamnos Lake	CUT	10	0.20	60.00	173	125	225
1150698440454	14123	Limber Lake	CUT	3	4.00	0.75	228	175	315
1150736440502	14104	Three Lake	BKT	7	1.00	7.00	234	180	305
1150736440502	14104	Three Lake	CUT	3	1.00	3.00	218	180	285
1150741440523	14102	14102	BKT	1	1.00	1.00	260	260	260
1150741440523	14102	14102	CUT	5	1.00	5.00	155	125	225
1150748440525	14100	14100	CUT	1	0.25	4.00	125	125	125
1150834440614	14062	Cony Lake	HYB	1	2.00	0.50	325	325	325
1150834440614	14062	Cony Lake	RBT	9	2.00	4.50	367	325	400

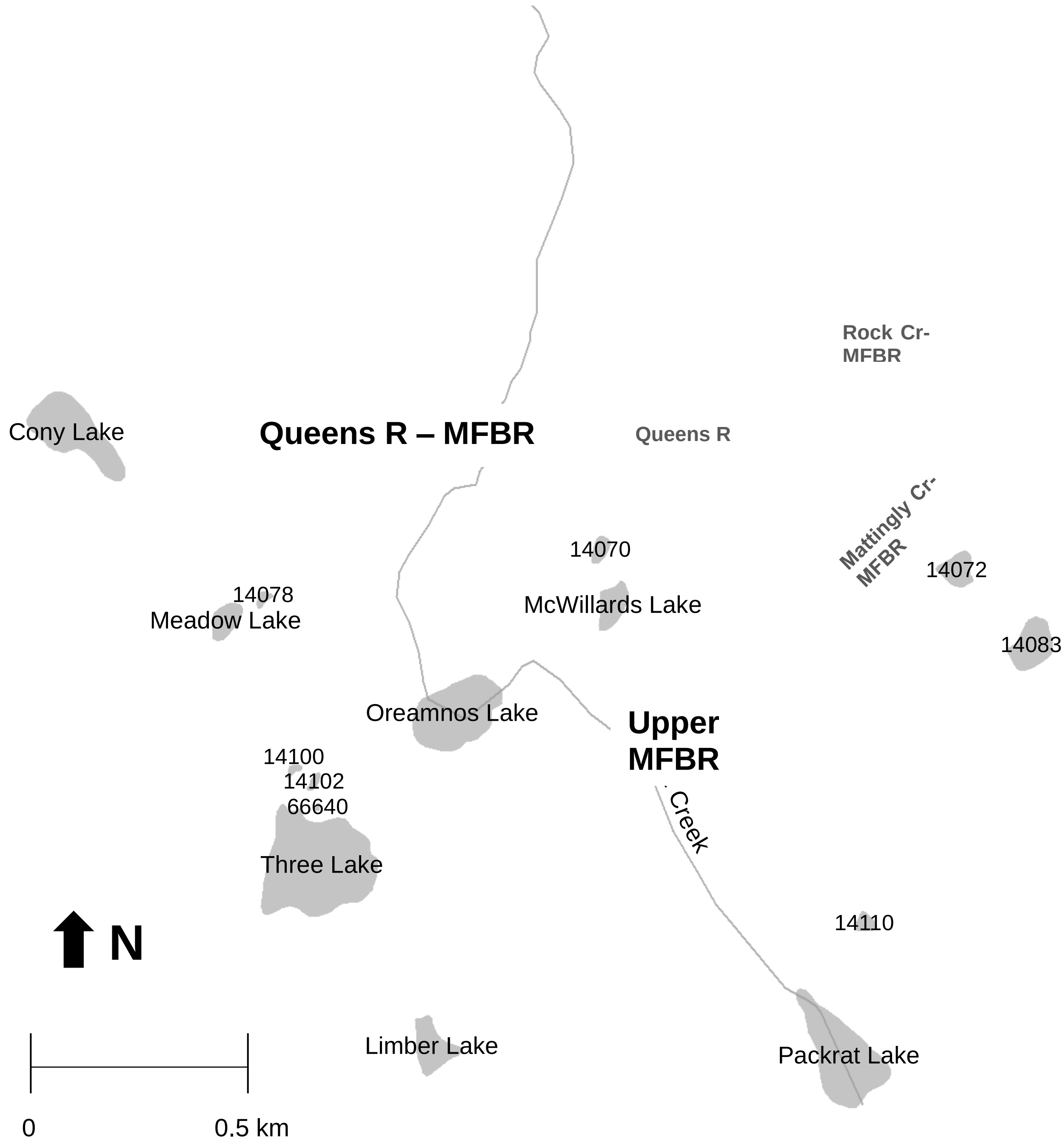


Figure 29. Location and names or Water ID# for alpine lakes sampled during 2018 in the headwaters of Goat Creek, a tributary to the upper South Fork Payette River. Additionally, an unnamed and unmapped lake adjacent and south of Meadow Lake was sampled.

RETURN-TO-CREEL AND TAGGING SUMMARY OF HATCHERY RAINBOW TROUT STOCKED IN 2017

ABSTRACT

Idaho Department of Fish and Game hatcheries remain integral to managing coldwater sportfishing opportunities in Idaho. With the initiation of the Tag-You're-It program, catch and harvest rates have been evaluated in numerous regional waters since 2006 and regional staff continue to work to collect tag return data for waters and stocking periods that have previously not been evaluated. In 2017, catchables stocked into two community ponds (Horseshoe Bend Mill and Sego Prairie) were tagged from March through October to evaluate seasonal angler use. In addition, split stocking at Lucky Peak Reservoir (April and May) was evaluated for a second year. Catch at Horseshoe Bend Mill Pond varied, with the lowest catch resulting from the June stocking. At Sego Prairie Pond, catch rates were in excess of 100%, regardless of stocking month. Days-at-large were less than 23 days for all pond stockings. Split stockings in Lucky Peak Reservoir showed similar total catch rates with a higher average number of days-at-large for the April stocking. These results continue to emphasize the importance and convenience of the Tag-You're-It program to monitor waters and locations on a case-by-case basis to inform management decisions, as catch and harvest rates often vary drastically among waters and stocking times.

Author:

John D. Cassinelli
Regional Fishery Biologist

INTRODUCTION

Idaho Department of Fish and Game (IDFG) hatcheries are integral to managing coldwater sportfishing opportunities in Idaho. The Southwest Region stocked approximately 250,000 “catchable” sized Rainbow Trout (10-12”) (herein “catchables”) into 49 different waters in 2017. The majority of the catchables stocked in the Southwest Region are reared at the Nampa Fish Hatchery (92%), with some coming from the Hagerman State Fish Hatchery (8%). With the initiation of the Tag-You’re-It program (see Meyer and Schill 2014), catch and harvest rates have been evaluated in numerous regional waters since 2006. These waters have been stocked with tagged fish as part of regional evaluations (Koenig et al. 2015) or as part of larger scale statewide hatchery evaluation studies (Cassinelli and Koenig 2013, Cassinelli 2014, 2015, and 2016). More recently, regional staff has worked to “fill in the gaps” and tag fish destined for waters that have not been previously evaluated or where previous evaluations have raised questions about stocking timings or strategies. Tag return information from these stockings continue to provide managers with valuable information that aids in adjusting or maintaining hatchery catchable stocking numbers at various waters throughout the region.

OBJECTIVE

1. Summarize tag return data for hatchery Rainbow Trout tagged in the Southwest Region in 2017.

METHODS

Locations and stocking months identified as lacking tag return data that received tagged catchables in 2017 included Horseshoe Bend Pond (March, May, June, and October) and Sego Prairie Pond (March, June, and October). Additionally, Lucky Peak Reservoir received tagged catchables in April and May as a second and final year to evaluate if a split stocking strategy prolonged the trout fishery. Prior to 2015, the entire allotment of catchables in Lucky Peak Reservoir was stocked in April of each year.

Prior to stocking, roughly 10% of the fish to be stocked into study waters were tagged with 70-mm fluorescent orange T-bar anchor tags. Fish were collected for tagging by crowding them within raceways and capturing them with dip nets to ensure a representative sample. Fish were sedated, measured to the nearest mm, and tagged just under the dorsal fin. Within 24 h of tagging, tagged fish were loaded by dip net onto stocking trucks with the normal lot of untagged fish and transported to stocking locations.

Angler catch and harvest data was based on the anchor tags that were reported by anglers. For a detailed description of the angler tag reporting system used, see Meyer and Schill (2014). In short, anglers could report tags using the IDFG Tag-You’re-It phone system or website (set up specifically for this program), as well as at regional IDFG offices or by mail. To facilitate angler reporting of tagged catchables, anchor tags were labeled with “IDFG” and a tag reporting phone number on one side, with a unique tag number and reporting website on the reverse side. Year-specific tag reporting rates and shedding rates were generated by IDFG’s hatchery trout evaluation staff using a subset of $50 reward tags and double tagging a subset of fish.

Total angler returns (c) were calculated as the number of tagged catchables reported as caught within one year of stocking divided by the number of tagged catchables stocked. This included all catchables caught, including those released back into the fishery. Angler returns were evaluated within the first year post-stocking. Total angler returns were adjusted (c'), to estimate the total proportion of catchables caught by anglers for each stocking event, by incorporating the angler tag reporting rate (λ), tag loss (Tag_l), and tagging mortality (Tag_m); (which was taken from Meyer and Schill [2014] to be 0.8%). Estimates were calculated for each individual stocking event using the formula:

$$c' = \frac{c}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

Finally, days-at-large of the catchables that were eventually caught post-stocking was calculated by subtracting the stocking date from the date that each angler reporting catching their tagged fish.

RESULTS

A total of 1,253 catchables were tagged and released in the three study waters in 2017. Total catch (± 90% CI) ranged from a high of 155.8 ± 42.8% for the March Sego Prairie Pond stocking to a low of 10.8 ± 8.2% for the June Horseshoe Bend Mill Pond stocking. Similarly, days-at-large were also variable ranging from a high of 154 d for the April Lucky Peak Reservoir stocking to a low of 7 d for the October Sego Prairie Pond stocking. All tag release numbers and estimates of harvest and total catch can be located in Table 17. At Horseshoe Bend Mill Pond, the average harvest rate was 75.6% of the total catch rate, and at Lucky Peak Reservoir it was 79.1%. This would indicate at these two waters, the majority of caught fish were harvested. At Sego Prairie Pond, the harvest rate was 58.4% of the total catch rate, indicating a much higher rate of catch and release at that water.

Similar to 2016, split stockings in Lucky Peak Reservoir in April and May showed similar total catch rates (49.4 ± 10.7% and 49.3 ± 10.7%, respectively) as well as similar days at large (154 d and 127 d, respectively) (Table 17). However, both the total catch and the days at large were substantially higher than those observed in 2016 (Figures 30 and 31).

DISCUSSION

Catch and harvest of catchable-sized hatchery Rainbow Trout across waters and stocking periods remain variable and continued tag return information is further helping managers refine when and where to stock. The waters and dates for which fish were tagged in 2017, were targeted to answer specific questions related to data gaps in our previous tag return information. Both Horseshoe Bend Mill and Sego Prairie ponds had little to no previous trout tag return data and angler use information was lacking. Both waters were stocked with tagged fish four times from spring through fall. Horseshoe Bend Mill Pond had moderate total catch in March, May, and October (all catch rates were in excess of 30%), but had poor total catch in June (10.8%). It is uncertain why June returns were so much lower. Temperatures might be limiting, but because water is diverted from the Payette River into the pond, this is unlikely. Other factors such as reduced angler effort, increased predation, or reduced oxygen could also be factors. These results emphasize the continued importance and convenience of utilizing the Tag-You're-It program to monitor waters and locations on a case by case basis to make the best management decisions, as catch and harvest rates often vary drastically across waters and stocking times, even if those waters and times are similar to each other.

Catchable stocking into Lucky Peak Reservoir is most beneficial in the early spring as reservoir levels are adequate and most angling effort at the reservoir occurs from early spring through mid-summer. Historically, Lucky Peak Reservoir received all its catchables for the year in April. To evaluate if it would help “spread out” the fishery, spring stocking was split across April and May. While this splitting strategy provided adequate catch rates spread out across a wider time frame in both 2016 and 2017, days-at-large were more variable with the May stocking providing a slightly longer fishing period in 2016 and the April stocking providing a longer fishing period in 2017. Interestingly, in 2017 the May stocking occurred 22 days after the April stocking but the average days at large from the April stocking was 24 days longer than the May stocking. So, while both stocking months provided similar catch, catch from the April stocking was more prolonged and the two stockings showed similar catch through time (Figure 32). However, the split stocking does appear to be providing a benefit of spreading out the fishery.

Using T-bar anchor tags to evaluate total catch and harvest across regional waters will continue to be an important management tool. The Tag-You’re-It program enables managers to collect a large amount of data with minimal costs and labor. We will continue to use this tool to further evaluate angler catch and harvest of hatchery trout in regional waters on an annual basis.

MANAGEMENT RECOMMENDATIONS

1. Consider additional evaluation of the June stocking at Horseshoe Bend Mill Pond
2. Consider increasing the stocking numbers into Sego Prairie Pond due to high use
3. Continue “split” stocking at Lucky Peak Reservoirs
4. Continue to utilize Tag-You’re-It to fill in the gaps in angler use of hatchery catchables at various regional waters across time and space

Table 17. Harvest and total catch (with 95% confidence intervals), and mean days at large by water and stocking date of hatchery catchable Rainbow Trout stocked in 2017.

Water	Stocking date	Number stocked	Harvest	95% CI	Total catch	95% CI	Median days-at-large
Horseshoe Bend Mill Pond	3/22/2017	90	43.3%	16.3%	48.7%	17.3%	16
Horseshoe Bend Mill Pond	5/18/2017	90	24.3%	12.2%	32.5%	14.1%	20
Horseshoe Bend Mill Pond	6/7/2017	90	8.1%	7.1%	10.8%	8.2%	18
Horseshoe Bend Mill Pond	10/16/2017	90	37.9%	15.2%	59.5%	19.1%	23
Lucky Peak Reservoir	4/10/2017	399	39.1%	9.1%	49.4%	10.7%	154
Lucky Peak Reservoir	5/2/2017	400	39.0%	9.1%	49.3%	10.7%	127
Sego Prairie Pond	3/28/2017	25	97.4%	39.1%	155.8%	42.8%	19
Sego Prairie Pond	6/2/2017	24	60.9%	33.8%	121.7%	42.0%	13
Sego Prairie Pond	6/7/2017	20	73.0%	39.3%	133.9%	45.9%	9
Sego Prairie Pond	10/16/2017	25	97.4%	39.1%	146.1%	42.6%	7

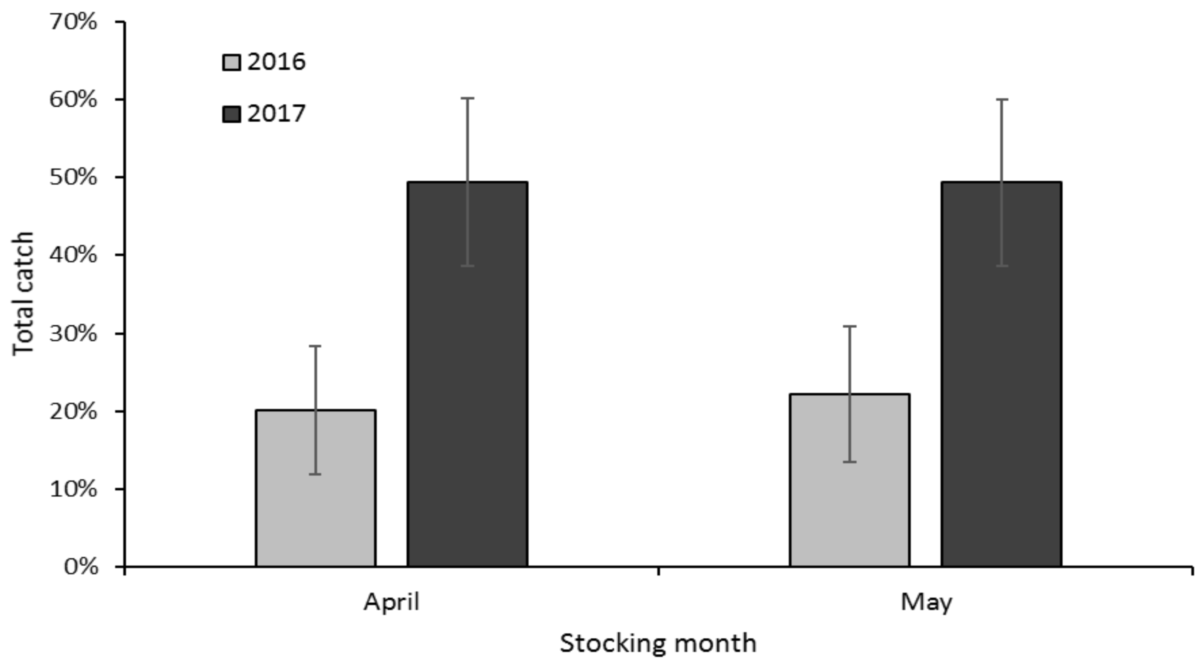


Figure 30. Total catch (with 95% confidence intervals) of catchable Rainbow Trout stocked in Lucky Peak Reservoir in April and May of 2016 and 2017.

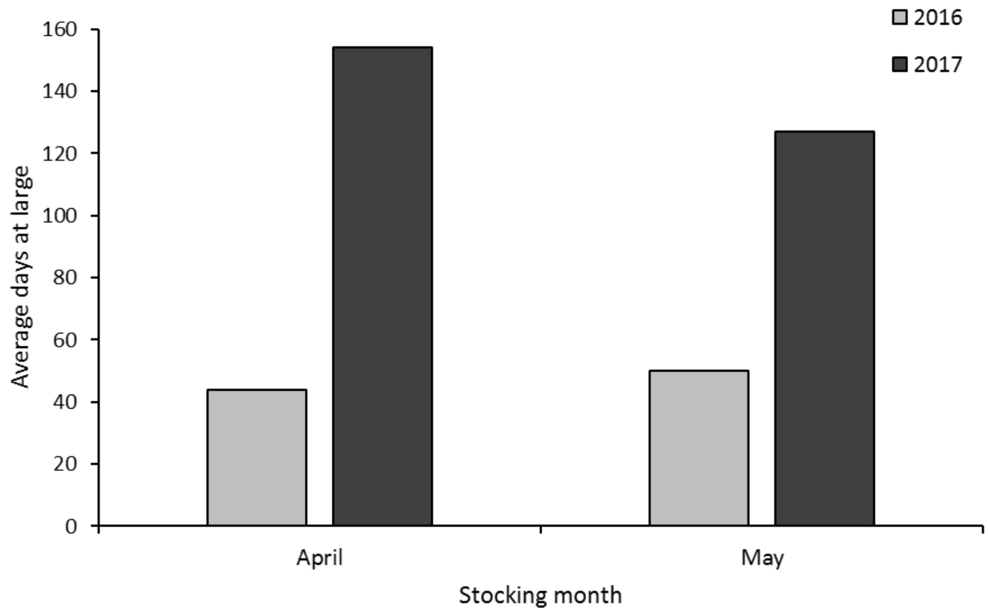


Figure 31. Average days at large of catchable Rainbow Trout stocked in Lucky Peak Reservoir in April and May of 2016 and 2017.

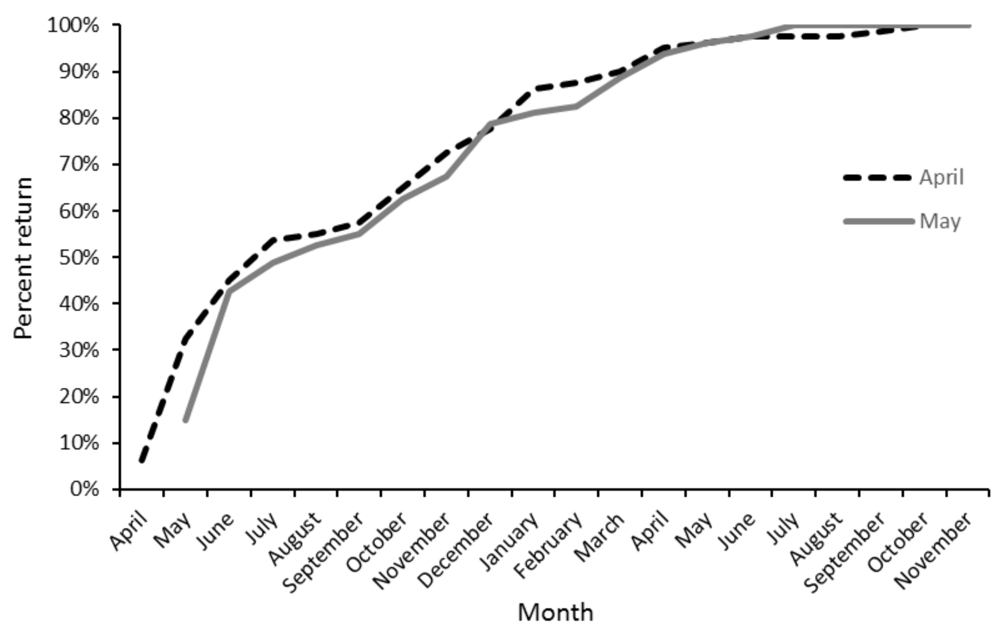


Figure 32. Cumulative percent return by month for catchable Rainbow Trout stocked in April and May of 2017 into Lucky Peak Reservoir.

LOWER BOISE RIVER FALL FRY MONITORING

ABSTRACT

From 2015-2018, the Lower Boise River from Harris Ranch downstream to the Ada County/Canyon County boundary, was sampled at 63 sites using shoreline backpack electrofishing to gain knowledge of juvenile species composition, abundance, and distribution. Sites included both mainstem and tributary/side channel habitat. A total of 155 age-0 Brown Trout and 208 age-0 Rainbow Trout were captured during the 2018 survey. In mainstem sites, mean density of age-0 Rainbow Trout was 0.06 ± 0.03 fish/m, while tributary/side channel sites had a mean density of 0.39 ± 1.11 fish/m. Brown Trout density in mainstem sites was 0.03 ± 0.03 fish/m and 0.22 ± 0.59 fish/m in tributary/side channel sites. Densities of age-0 trout continued to differ spatially between species. Following flood-level flows in 2017 and reduced age-0 densities for both species, overall densities for both Brown and Rainbow trout were the highest for all four years of the surveys in 2018 indicating a potential increase in spawning habitat as a result of high flows. In correlating flows with critical periods of trout spawning, incubation, and emergence, there is evidence that alevin emergence might be the critical period impacted by Lower Boise River flows. Further work is needed to identify these important life stage windows and further identify the impacts of flows on both Brown and Rainbow trout recruitment. These surveys continue to improve our understanding of wild Rainbow and Brown Trout populations in the Lower Boise River.

Author:

John D. Cassinelli
Regional Fisheries Biologist

INTRODUCTION

The Lower Boise River segment of the Boise River watershed begins at Lucky Peak Dam and continues for 103 km (64 mi) to its confluence with the Snake River near Parma, Idaho. The river flows through a variety of urban and agricultural settings and has been heavily altered by associated land and water uses (MacCoy 2004). Flows are regulated for both agricultural demands and flood control. Additionally, channel alteration has occurred throughout this reach. Higher than natural flows generally occur between April and September (mean = 48 m^3/s) and lower than natural flows occur between October and March (mean = 14 m^3/s). Furthermore, there are approximately 28 diversions along the Lower Boise River that supply water to various irrigation districts. There are approximately fourteen major water inputs to the Lower Boise River, including drains or tributaries, water treatment facilities, and irrigation returns. The surrounding land and water use practices have resulted in significant impacts on water quality and biological integrity, including elevated sediment and nutrient levels, as well as increased water temperatures (MacCoy 2004).

The Boise River fish species assemblage shifts from primarily coldwater obligate species in the upper sections upstream of Glenwood Bridge, to a warmwater species assemblage near Middleton downstream to the Snake River, with a transition zone in between. Species include Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta,* Mountain Whitefish *Prosopium williamsoni*, and sculpin *Cottus sp.* in the upstream coldwater portion of the river. Warmwater species including Smallmouth Bass *Micropterus dolomieu*, Channel Catfish *Ictalurus punctatus*, Common Carp *Cyprinus carpio*, Redside Shiner Richardsonius balteatus, dace Rhinichthys sp, and sucker *Catostomus sp.* are found more frequently in the lower portion downstream of Middleton, Idaho.

The Lower Boise River and its riparian corridor are valued for irrigation, recreation, and the inhabiting fish and wildlife. Prior to the 1970s, water quality and quantity were not conducive for sustaining quality fish populations. The Clean Water Act of 1972 and the resulting temperature and suspended sediment criteria acted as a catalyst for initiating water quality improvements on the river. During the past 20-30 years, several agencies and municipalities have worked to improve water quality by improving agricultural, industrial, and waste and storm water management.

The Lower Boise River fishery supports substantial angling effort throughout the year (Kozfkay et al. 2010), supported primarily by both wild and hatchery-origin Rainbow and wild Brown trout. Prior to establishing standardized monitoring sites in 2004, non-standardized sampling efforts on the Lower Boise River captured few wild trout. More recent survey data and anecdotal information suggests that the number of wild Rainbow and Brown trout in the river has improved over the last 20 years. Wild Rainbow Trout in particular have increased nearly seventeen-fold between 1994 and 2010 (Kozfkay et al. 2010). The increase in wild trout abundance coincides with the establishment of minimum winter flows of 7 m^3/s in 1984. Wild trout populations also likely benefited from water quality improvements and an increase in catch-and-release practices over the same period.

During the past four years, numerous sampling efforts have been conducted on the Lower Boise River. These efforts have helped managers monitor adult population trends, assess wild trout distribution and angler use, and monitor age-0 trout production and distribution. Results of these studies are available in Butts et al. (2016), Peterson et al. (2018), Cassinelli et al (2018) and continued in this report chapter.

METHODS

Similar to 2015, 2016, and 2017, the October distribution of age-0 wild trout in the Lower Boise River was again investigated in 2018. The study included approximately 48 km of river between the Highway 21 bridge and the Canyon/Ada county line, which is the approximate lower extent of year-round trout habitat in the Lower Boise River. Fourteen river sections were delineated in this reach to describe spatial differences in production (Table 18). The 14 river sections (1.6 to 7.6 km in length) were chosen based on locations of prominent access points, landmarks, or river barriers. Within these 14 mainstem sections were 54 mainstem sampling sites. All but one of the sections contained four sites, with one section having two sites (Table 18). Additionally, there were four tributary/side channel sections containing 9 sample sites (Table 18). The 63 sample sites are outlined in Figures 33, 34, and 35.

Age-0 Rainbow and Brown trout production was evaluated at the 63 sites from October 24-November 14, 2018. Mainstem sites were stratified by river section with half of the mainstem locations selected randomly and the other half selected by crews during the initial sampling year (2015). For the non-random sites, crews selected sites suspected to be good juvenile trout habitat based on visual habitat features such as near shore complexity, presence of woody debris or vegetation, and proper flow and depth. In 2015, sites were 30-m long while in 2016, sites were 100-m long. Prolonged sites in 2016 were the result of a miscommunication with field staff. Sample sites were again 30-m long in both 2017 and 2018. During mainstem sampling, the area from the one shoreline out to approximately 4 m was sampled. For tributary or side channel sample sites, the entire channel was sampled as these side channels were typically less than 4 m wide. A single, upstream electrofishing pass was completed at each site. All fish were identified and counted, while trout were measured for total length. Fish densities (fish/m) ± 95% confidence intervals were calculated.

RESULTS

Similar to previous years, numerous species were observed during shoreline surveys for juvenile trout, including dace sp., sculpin sp., and sucker sp. A total of 165 Brown Trout (of which 155 were age-0) and 213 Rainbow Trout (of which 208 were age-0) were captured during the survey. Brown Trout catch ranged from 0 to 31 fish per site, while Rainbow Trout catch ranged from 0 to 27 fish per site in the 63 sites sampled in 2018 (Table 19). Lengths of Brown Trout ranged from 81 to 560 mm, and lengths of Rainbow Trout ranged from 66 to 430 mm. Length-frequency distribution analysis suggested that Rainbow Trout <160 mm and Brown Trout <180 mm were likely age-0 trout (Figure 36).

Age-0 trout densities continue to vary by location, habitat type, and species (Figure 37). However, after observing the lowest overall age-0 trout densities of the four years of the study in 2017, densities in 2018 were the highest observed across all four years for Brown Trout and the second highest observed for Rainbow Trout. As in previous years, the highest densities of mainstem Rainbow Trout continue to be sampled upstream of Eagle (Figure 37). Mean density for age-0 Rainbow Trout was 0.13 ± 0.11 fish/m for the entire survey. The overall Rainbow Trout density was double the overall density observed in 2017, 84% higher than the 2016 density, and 7% lower than the 2015 density. Main channel sites consistently have lower densities than side channel/tributary sites. This trend continued in 2018 (Figure 37). In mainstem habitats, mean density of age-0 Rainbow Trout (fish/m) was 0.06 ± 0.03 while tributary/side channel sites had a mean density of 0.39 ± 1.11. Heron Creek had the highest density of age-0 Rainbow Trout. Within mainstem sites, densities of age-0 Rainbow Trout were highest upstream of the Glenwood Bridge (Figure 37).

Brown Trout are found most consistently downriver from the Glennwood Bridge (Figure LB5). Overall mean density (fish/m) of age-0 Brown Trout was 0.065 ± 0.062. Overall 2018 Brown Trout densities were 87% higher than Brown Trout densities in 2017, double the 2016 densities, and 33% higher than 2015 densities (Figure 38). Density in mainstem sites was 0.03 ± 0.03 (fish/m) and 0.22 ± 0.59 fish/m in tributary/side channel sites. For tributary/side channel sites, age-0 Brown Trout density was highest in Loggers Creek.

Selected sites continue to have higher densities than randomly assigned sites for both Rainbow and Brown trout. With the exception of 2016, Rainbow Trout densities have been higher at select sites each sampling year. However, the difference was slight in 2018 with select site density being only 2% higher than random site densities (Table 20). Similar to Rainbow Trout, Brown Trout densities at selected sites has also been higher in all years except 2016. In 2018, select site densities for Brown Trout were 40% higher than random site densities (Table 20).

DISCUSSION

Wild trout fall fry densities in the Lower Boise River are relatively low. Averaging all four years of lower Boise River fall surveys, age-0 Rainbow Trout densities were 0.1 fry/m. By comparison, fall age-0 wild Rainbow Trout densities in the SF Boise River averaged 1.6 fry/m (Peterson et al. 2018). In other words, the SF Boise River had fall densities over 15 times higher than the Lower Boise River. However, it is also important to note that while SF Boise River age-0 trout are much more abundant in the fall, average length was 56 mm, while average length in the Lower Boise River was 101 mm. Spring fry densities in the SF Boise River averaged 0.3 fry/m. While we do not have a direct measure of over winter age-0 survival in the Lower Boise River, these larger fish survive at a much higher rate. Smith and Griffith (1994) reported a critical size of 100 mm in October for over winter survival of age-0 trout in the Henrys Fork of the Snake River. While occurring in lower numbers, Lower Boise River age-0 Rainbow Trout appear to be healthy and from a size-only perspective, are large enough to experience high levels of over-winter survival. Due to the inconsistent and often early flow releases in the Lower Boise River, consistently assessing spring fry densities to calculate overwinter survival would be difficult.

Continued observations of low fall densities of age-0 trout in the Lover Boise River emphasize the river’s relative lack of spawning and nursery habitat. This fourth year of fall shoreline surveys provided further insight into identifying the importance of suitable rearing areas (and to a lesser extent, spawning areas). Side channels and tributary habitat continue to be the preferred spawning and rearing areas based on relative abundance of age-0 trout. In all four years of the survey, tributary or side channel sites had greater than three times the densities of age-0 Rainbow and Brown trout than mainstem sites. This is not surprising given that the Lower Boise River has been extensively developed and channelized, making these habitat types relatively rare when compared to a more naturally-functioning river. Previous studies have emphasized greater fish production in tributary and lateral river habitat (Moore and Gregory 1988; King 2004) and decreased nursery habitat in channelized rivers (Jurajda 1999). Protecting these types of habitats and finding additional opportunities to improve larger sections of existing side channel or tributary habitat remains one of the most important wild trout-specific management components on the Lower Boise River.

Following three years of decreasing overall fall densities of both age-0 Rainbow and Brown trout, densities of both species rebounded in 2018. In fact, both Brown and Rainbow trout densities rebounded from the lowest observed in the four years of monitoring in 2017 to the highest observed in 2018. Brown Trout showed a greater than six-fold increase while Rainbow Trout densities showed a greater than one-fold increase (Figure 38). The overall increased fry densities we observed in 2018 could be a direct result of increased spawning habitat resulting from the high 2017 flows. Studies have shown an increase in salmonid spawner abundance resulting from increased available habitat following periods of flooding, especially in regulated rivers (Ortlepp and Mürle 2003; Valdez et al. 2001).

Across the four years of monitoring, flows in the Lower Boise River have been highly variable (Figure 39). In 2015, flows were well below average while in 2017 flows reached record highs for a prolonged period. Both 2016 and 2018 flows were more average. This has enabled us to look at effects to fry abundance resulting from a wide range of flows. Flows relative to fall fry abundance are most critical during periods when trout are spawning, eggs are incubating in the gravel, and alevins are emerging from the gravel. Bettoli et al. (1999) found that highly fluctuating flows from hydropower operations scoured away trout eggs and fry in a Tennessee tailwater. Fausch et al. (2001) noted that high spring flows from natural floods or artificial flow fluctuations can scour Rainbow Trout eggs and larvae from redds. Jensen and Johnson (1999) found that the highest flow-induced mortality of Brown Trout fry in a Norway River occurred at the alevin stage, where both low water temperatures and high flows were detrimental. Dibble et al. (2015) found that in in tailwater fisheries across western North America, recruitment of both Brown and Rainbow trout is regulated primarily by flow management and that Rainbow Trout recruitment was highest with high winter and low spring flows, while Brown Trout recruitment was negatively correlated with specific spring discharge. Finally, Budy et al. (2008) found that if flows are substantially increased before, or as Brown Trout fry emerge, the high water velocity could result in direct mortality through bed scour while fry are still in the gravel and lethal displacement during emergence. In the Lower Boise River, Rainbow Trout peak spawning likely occurs from mid-April through mid-May, with peak emergence from mid-June through early July. Peak Brown Trout spawning likely occurs from mid-October through mid-November with peak emergence from mid-March through mid-April. With the exception of the Brown Trout spawn, the other critical periods have occurred during periods of highly variable flow over the four years of our surveys (Figure 39). We plotted year- and species-specific mainstem fry densities overlaid with average flow for the period of alevin emergence and found that for both Brown and Rainbow trout, there was a relationship between flow and density (Figures 40 and 41). While of interest, this relationship needs to be studied further. Additional years of density and flow data along with a better understanding of when species-specific peak emergence occurs on the Lower Boise River will provide insight into whether or not flows at emergence are in fact limiting of trout recruitment.

These shoreline surveys continue to show spatial differences in recruitment between Rainbow and Brown trout in the Lower Boise River. Wild Rainbow Trout production continues to be highest in areas upstream of the Plantation section, while wild Brown Trout production is highest between Eagle and Star. Spatial variation in production between the two species are likely influenced by variability in water velocity, water temperature, and habitat complexity across river sections. One of the main goals of these surveys is to gain a better understanding of the specific conditions that influence wild Rainbow and Brown trout-specific recruitment. Continued work collecting species-specific densities from the shoreline surveys within the Lower Boise River will benefit fisheries management in the Lower Boise River.

MANAGEMENT RECOMMENDATIONS

1. Repeat the fall shoreline electrofishing surveys for age-0 Rainbow and Brown trout in 2019 to assess annual variability in production.
2. Seek opportunities to improve side channel rearing habitat conditions to improve trout fry survival.

Table 18. Description of river sections used for age-0 trout sampling on the Lower Boise River during the fall 2015, 2016, 2017 and 2018.

Section	Description	Upstream km	Downstream km	Total km	No. of sites
Mainstem Lower Boise River					
Harris Ranch	Hwy 21, Diversion Dam to Barber Dam	99.8	95.0	4.8	4
Barber	Barber Dam to East Parkcenter Bridge	95.0	91.7	3.2	4
Special Reg	East Parkcenter Bridge to Boise Footbridge	91.6	88.7	2.9	4
Morrison	West Parkcenter Bridge to Americana	86.9	83.7	3.2	4
Americana	Americana to Cascade Outfitters (45th St)	83.7	81.3	2.4	4
Plantation	Cascade Outfitters (45th St) to Glenwood	81.3	75.6	5.6	4
Glenwood	Glenwood to start of Eagle Island Start	75.6	73.2	2.4	4
Eagle South	Behind Concrete plant near start of Eagle Island	10.5	6.6	3.9	4
Eagle North	Behind Concrete plant near start of Eagle Island	73.2	69.0	4.2	4
Linder North	Eagle Rd (N. Bridge) to Linder North	69.0	62.9	6.1	4
Star (North)	Linder Road (N. Bridge) to confluence with south channel	63.1	61.2	1.9	4
Star (South)	Linder Road (S. Bridge) to confluence with north channel	1.6	0.0	1.6	2
Star	North & South channel confluence to Star Bridge	61.2	54.7	6.4	4
Can-Ada	Star Bridge to Lansing Lane	54.7	47.0	7.7	4
Tributray/Side Channel					
Loggers Creek	Entire length			5.0	5
Warm Springs Creek	Section bordering Warm Springs Golf Course			0.1	1
Harris Creek	Pond outlet to confluence			0.1	1
Dry Creek	W Floating Feather Road to Confluence			2.2	2

Table 19. Trout numbers by sample reach and presence/absence of non-game species and Mountain Whitefish for shoreline fall sampling on the Lower Boise River and tributaries/side channels in 2018.

Section	Brown Trout	Rainbow Trout	Bluegill	Dace (Var. Sp.)	Largemouth Bass	Mountain Whitefish	Northern Pikeminnow	Oriental Weatherfish	Green Sunfish	Redside Shiner	Sculpin (Var. Sp.)	Sucker (Var. Sp.)	Grass shrimp
Harris Ranch				P							P	P	
Barber		12		P						P	P	P	
Special Reg.	1	14								P	P	P	P
Morrison	2	11		P							P		
Americana	4	9		P	P			P			P	P	
Plantation	2	4		P		P					P	P	
Glenwood	6	3		P	P						P	P	
Eagle North	2	9		P	P	P					P	P	
Eagle South		8		P		P					P	P	
Linder North	24	23		P	P	P	P			P		P	
Star North	4			P	P		P					P	
Star South				P	P							P	
Star	7	5		P	P							P	
Can-Ada	1			P			P		P			P	
Loggers Creek	97	81		P	P	P		P			P	P	
Heron Creek	4	27			P		P				P	P	
Warm Creek	1	2									P		
Dry Creek						*Sites dry*							
Grand Total	155	208											

Table 20. Rainbow and Brown Trout fry densities (fish/m) for randomly assigned vs. selected sites for 2015, 2016, 2017, and 2018 fall sampling. Density comparison are for sites on the mainstem Lower Boise River only and exclude tributary sites.

	Brown Trout		Rainbow Trout	
Sample year	Random sites	Select sites	Random sites	Select sites
2015	0.016	0.021	0.050	0.094
2016	0.024	0.019	0.046	0.040
2017	0.004	0.011	0.027	0.049
2018	0.023	0.038	0.042	0.043
Ave	*0.017*	*0.022*	*0.041*	*0.061*

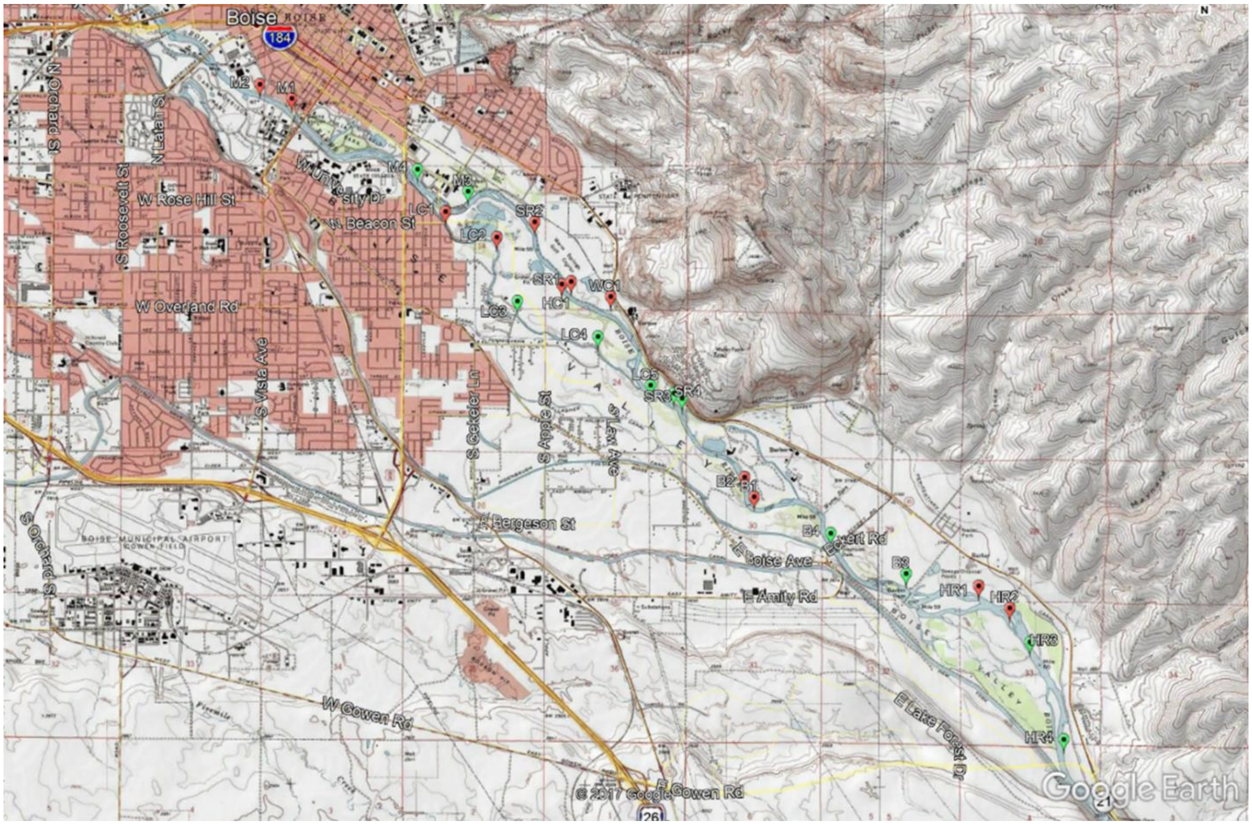


Figure 33. Location of sample sites in the Lower Boise River between Highway 21 (upriver) and Interstate 184 (downriver). This section includes all sights in Morrison, Special Reg, Barber, and Harris Ranch sections as well as the Loggers Creek side channel and Harris Creek and Warm Springs Creek tributaries. Orange sites were randomly chosen, while green sites were chosen based habitat characteristics.

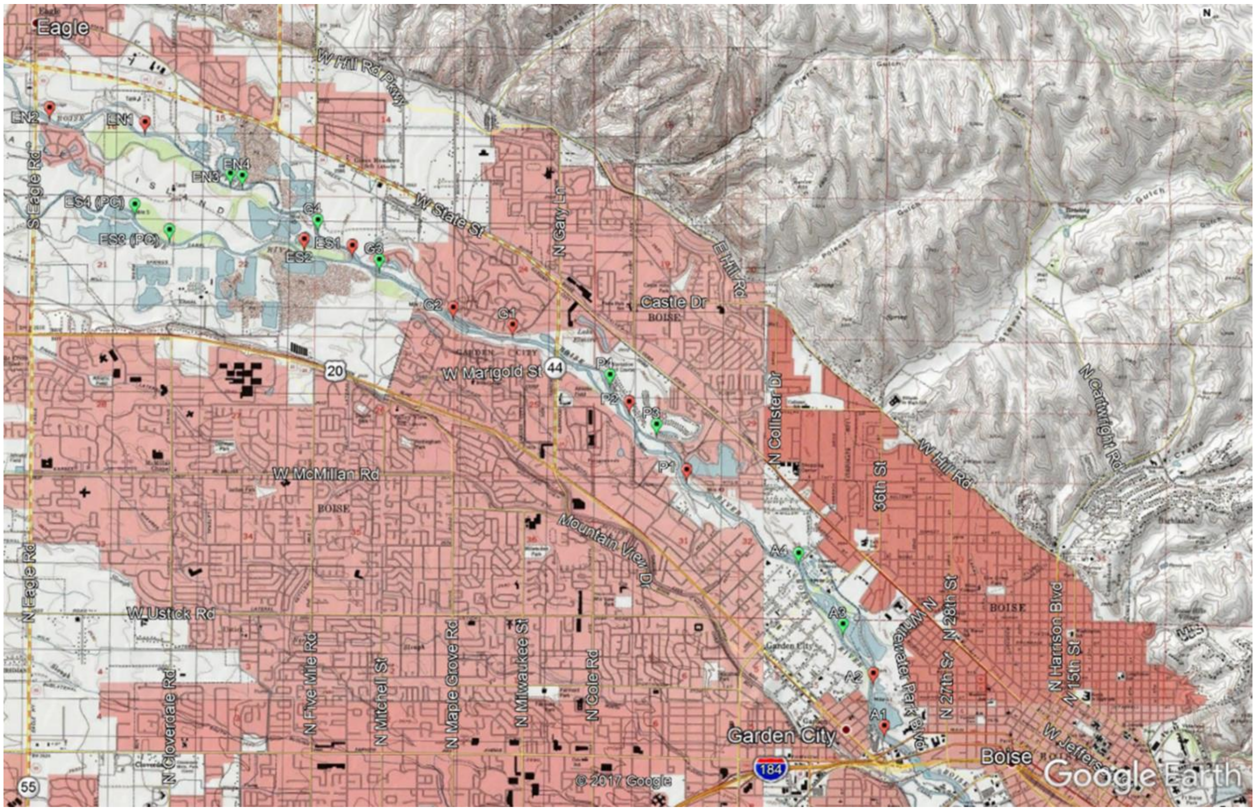


Figure 34. Location of sample sites in the Lower Boise River between Interstate 184 (upriver) and Eagle Road (downriver). This section includes all sights in the Eagle North, Eagle South, Glenwood, Plantation, and American sections. Orange sites were randomly chosen, while green sites were chosen based habitat characteristics.

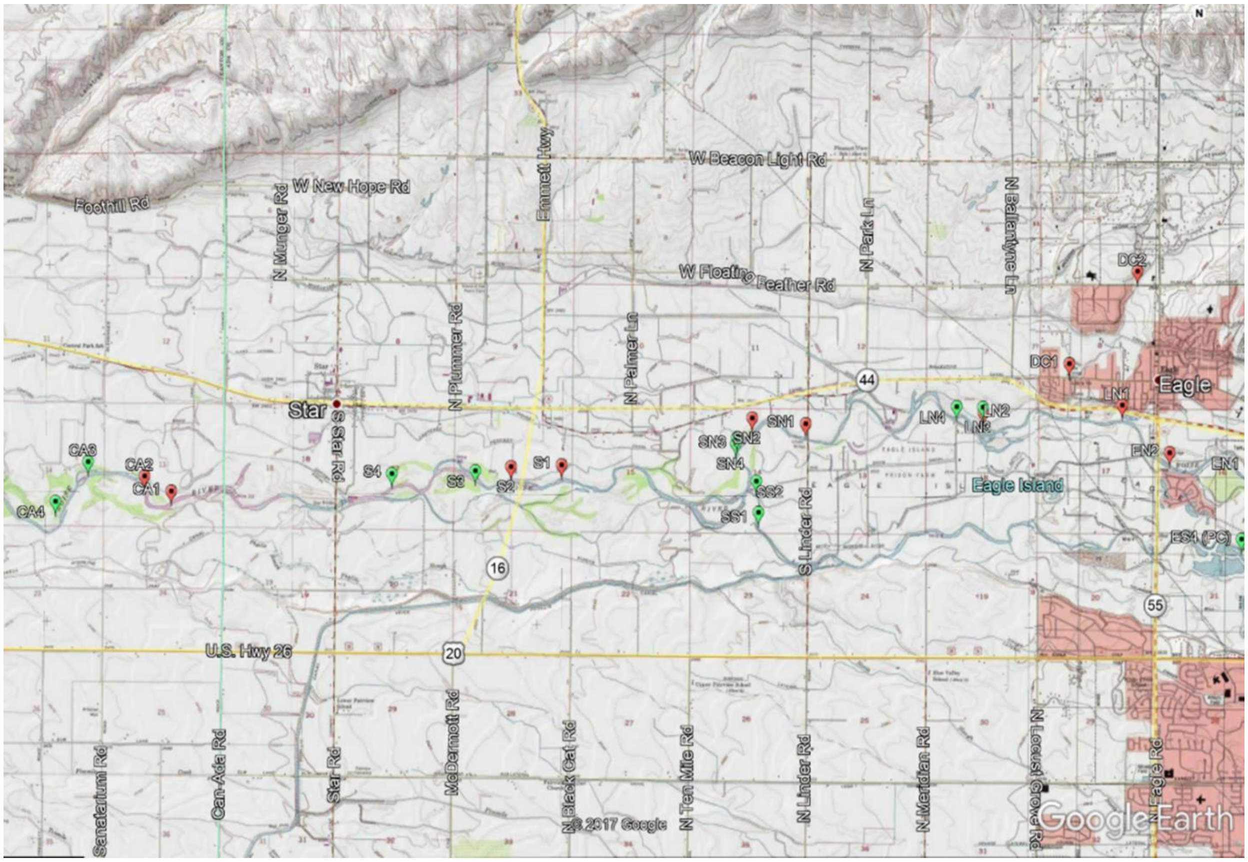


Figure 35. Location of sample sites in the Lower Boise River between Eagle Road (upriver) and the lowest sites downriver of the Canyon/Ada county line. This section includes all sights in the Can/Ada, Star, Star North, Start South, and Linder North sections. As well as the Dry Creek tributary. Orange sites were randomly chosen, while green sites were chosen based habitat characteristics.

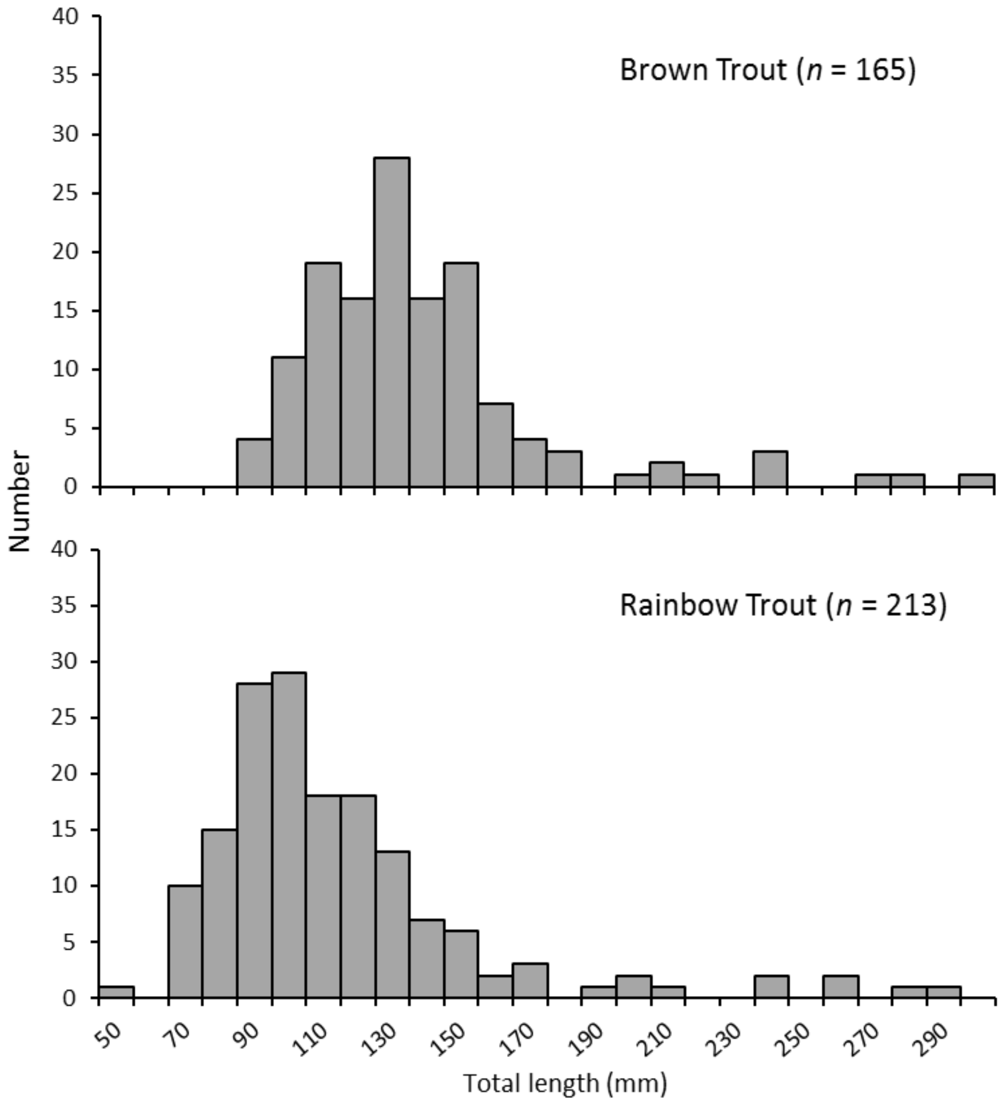


Figure 36. Length-frequency distribution of wild Brown Trout and Rainbow Trout sampled during shoreline electrofishing surveys in the Lower Boise River and its tributaries in 2018.

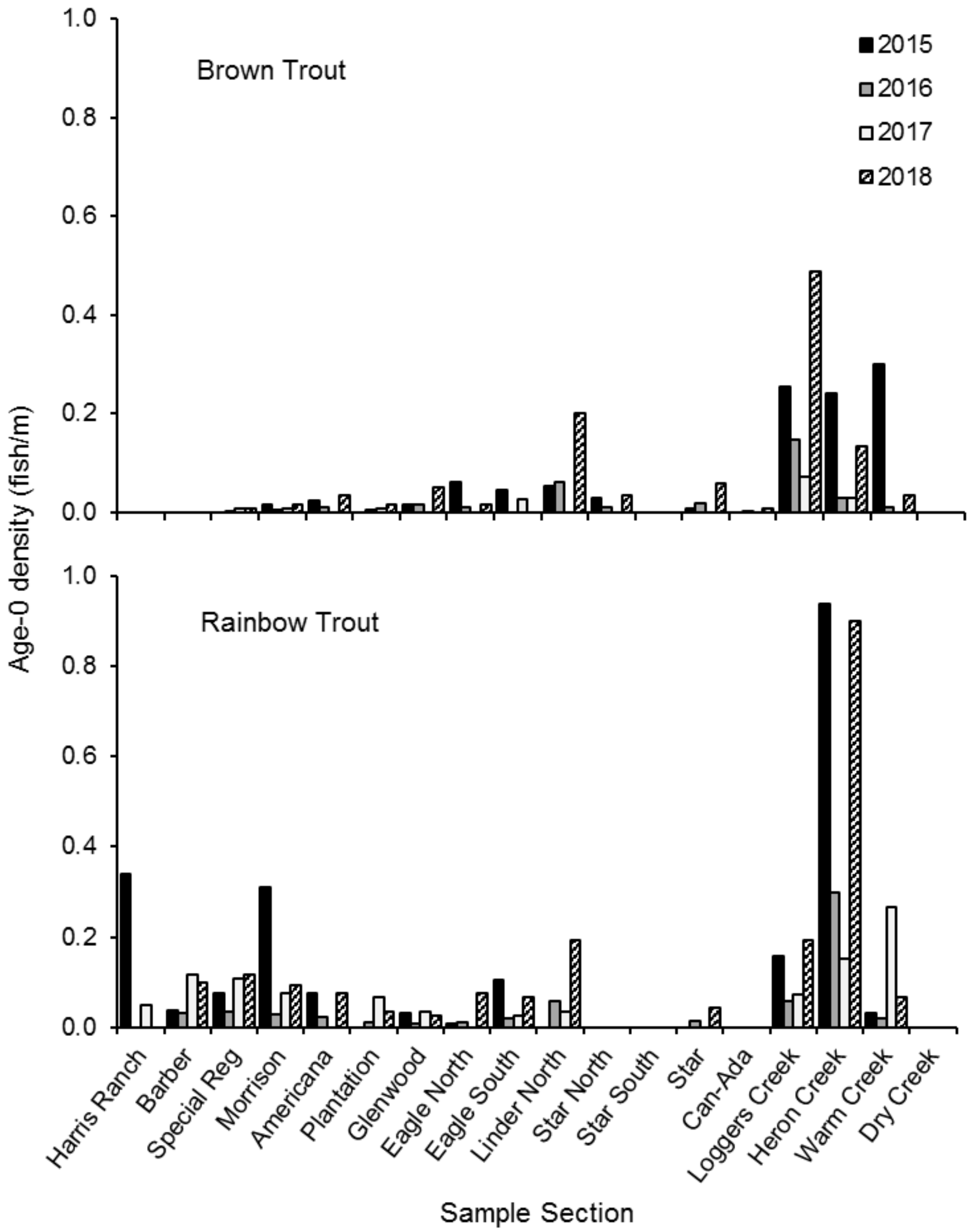


Figure 37. Densities (fish/m) of age-0 wild Brown Trout and Rainbow Trout, by sample section, sampled during shoreline electrofishing surveys in the Lower Boise River and its tributaries in 2015, 2016, 2017, and 2018.

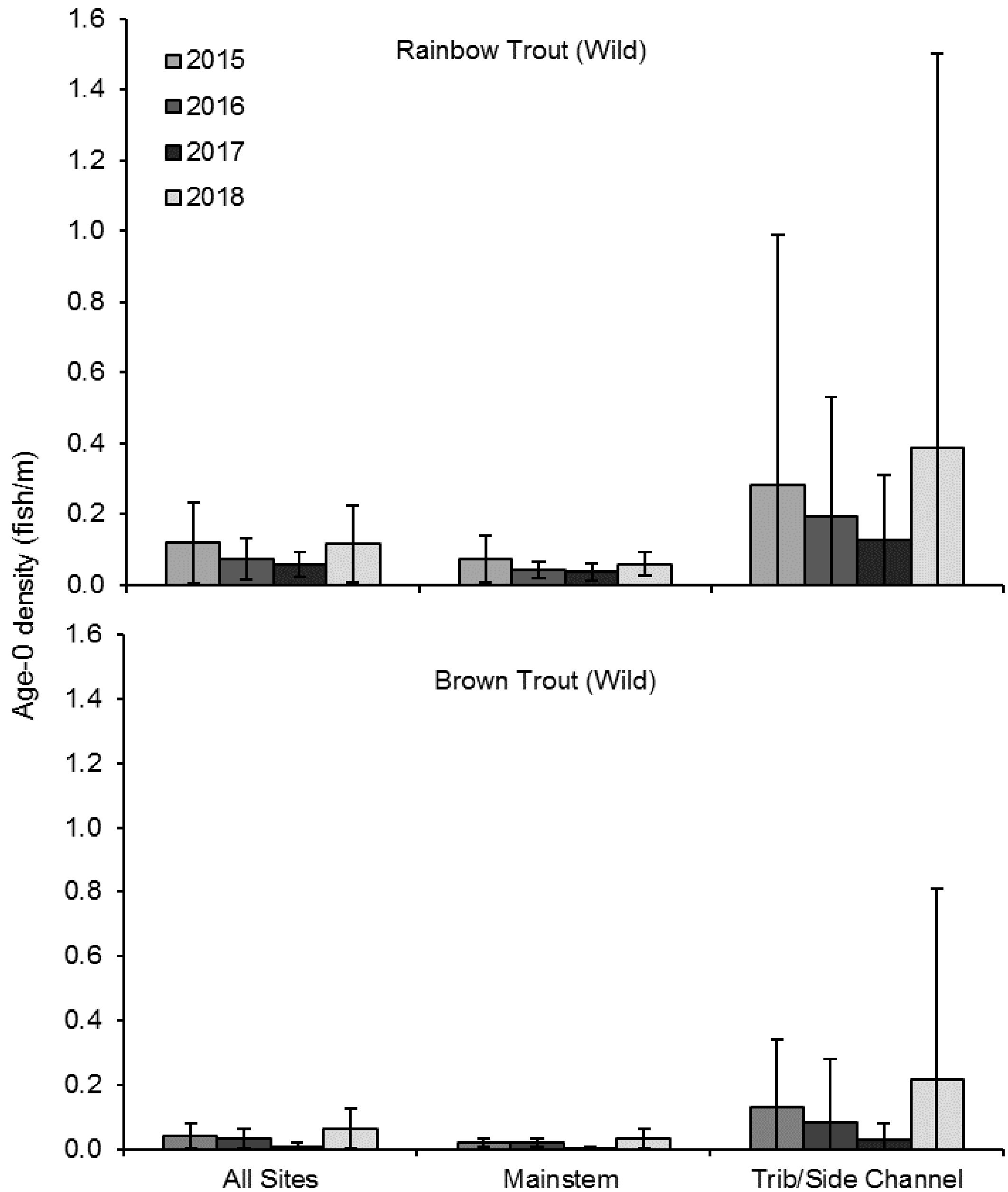


Figure 38. Densities (fish/m), with 95% confidence intervals, of age-0 wild Brown Trout and Rainbow Trout sampled in the all sections, mainstem Boise River sections, and side channel/tributaries during shoreline electrofishing surveys in 2015, 2016, 2017, and 2018.

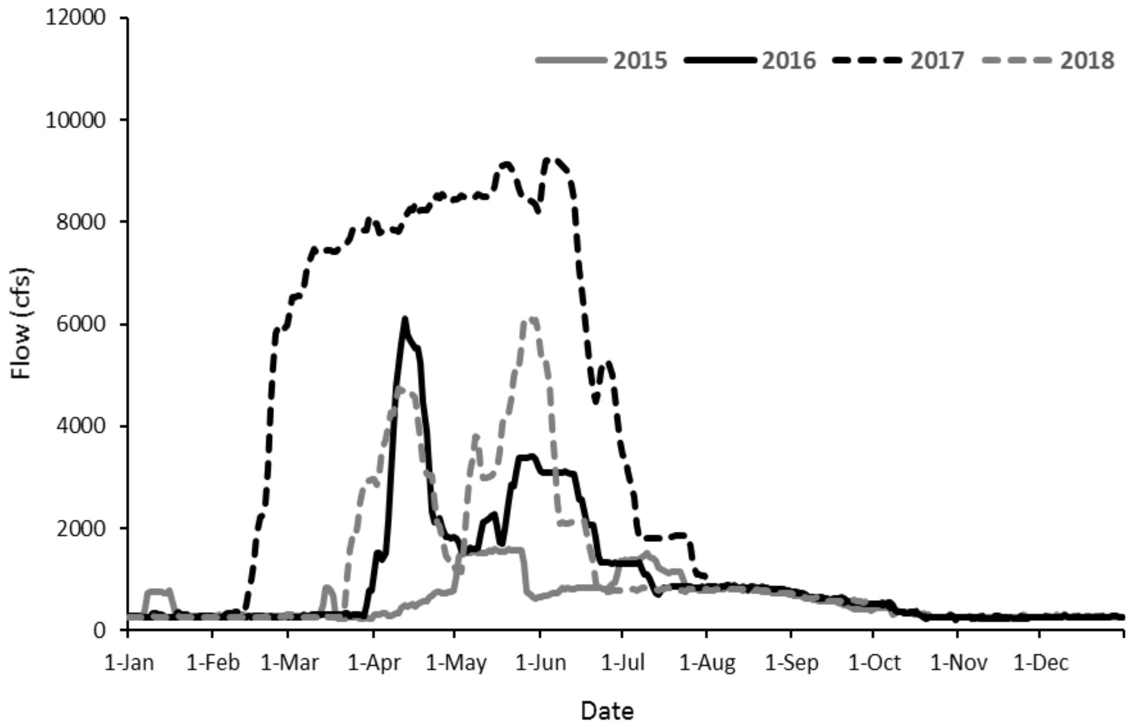


Figure 39. Lower Boise River flows at the USGS Glenwood gauge across the calendar year for 2015-2018.

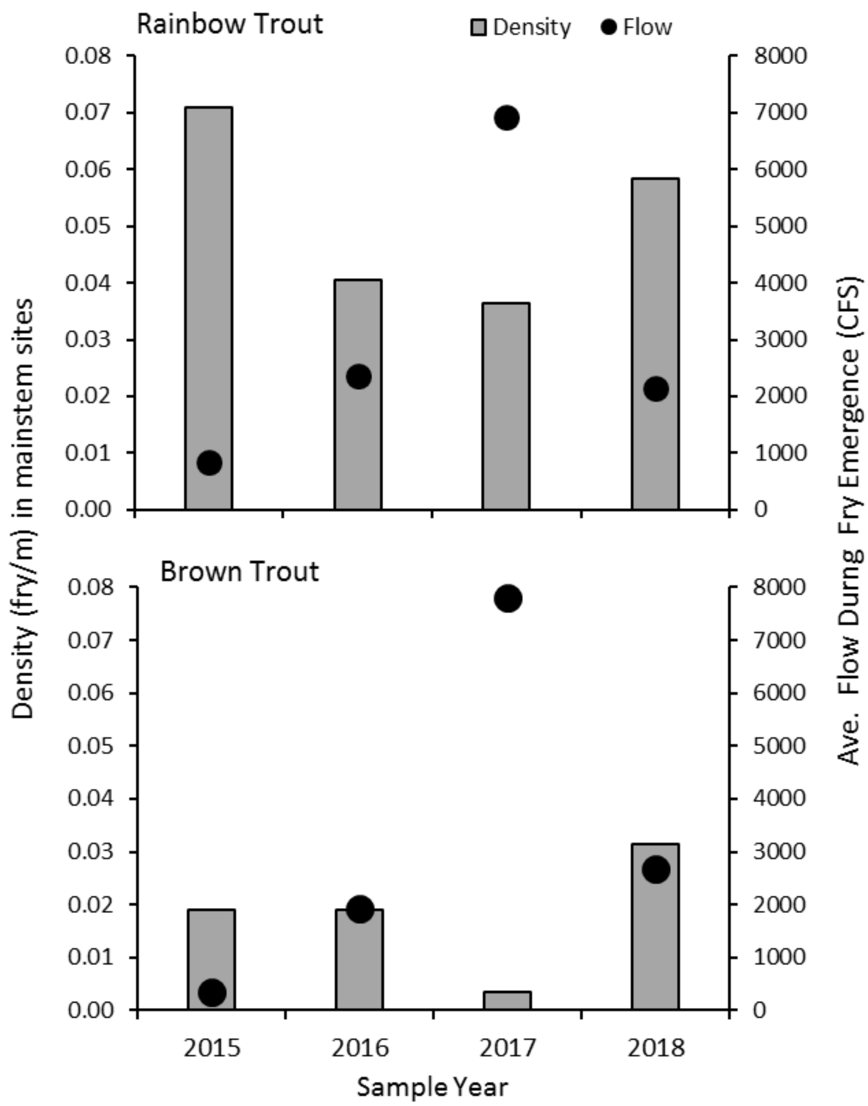


Figure 40. Rainbow and Brown fry trout densities (fry/m) in the mainstem Boise River plotted against average river flow (cfs) when alevins are emerging from the gravel. Rainbow Trout average flow was from June 15 through July 15 while Brown Trout average flow was from March 15 through April 15.

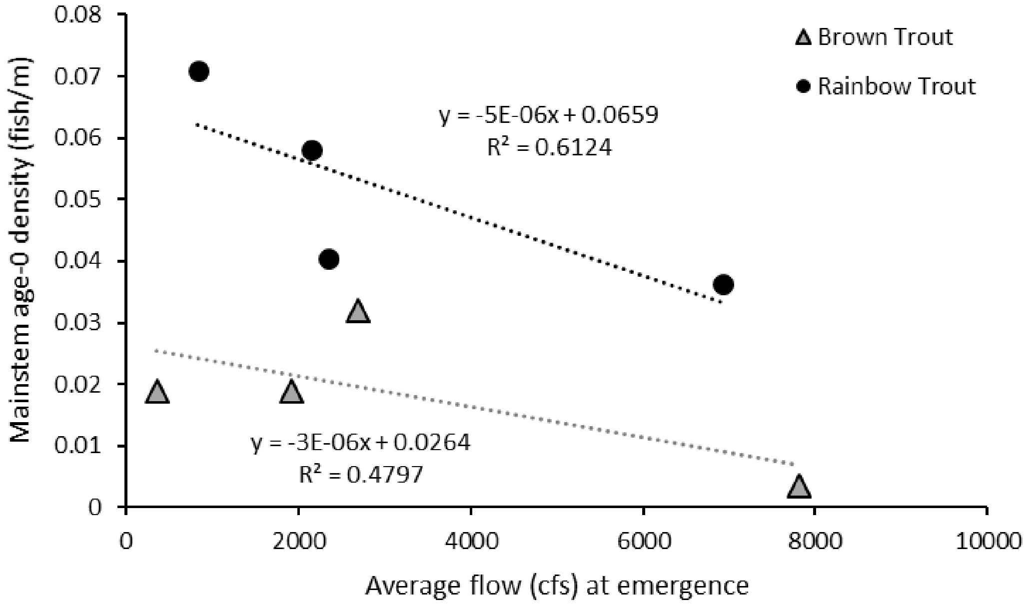


Figure 41. Rainbow and Brown fry trout densities (fry/m) in the mainstem Boise River plotted against average river flow (cfs) when alevins are emerging from the gravel, with associated trend lines and R^2 values.

NORTH FORK BOISE RIVER SNORKEL SURVEYS

ABSTRACT

The North Fork of the Boise River (NFBR) runs 80 km, originating from the west side of the Sawtooth Mountains and terminating at the confluence with the Middle Fork Boise River. The granitic soils of the Idaho Batholith make the NFBR relatively unproductive. Native gamefish in the NFBR consist of Redband Trout *Oncorhynchus mykiss*, Bull Trout *Salvelinus confluentus*, and Mountain Whitefish *Prosopium williamsoni*. During the summers of 2017 and 2018, fifteen historic trend sites were surveyed using entire-width snorkeling. Trends in relative abundance were compared using species-specific density estimates for each site and comparing amongst years and river sections. In 2018, wild Redband Trout site-specific densities ranged from 0 to 4.05 fish/100 m^2 with a mean of 1.77 fish/100 m^2. Mountain Whitefish site-specific densities ranged from 0 to 5.38 fish/100 m^2 with a mean of 1.37 fish/100 m^2. Five Bull Trout were observed, as well as several native non-gamefish species. With the exception of Westslope Cutthroat Trout, densities for all other observed species increased from 2017 surveys. There remains a strong correlation in densities among the various species observed in the NFBR among sample periods. There also remains a strong positive correlation between Redband Trout densities and average stream flow across the three years prior to sampling. Due to the limited accessibility and generally low densities of wild Redband Trout, the upper and lower sections of the NFBR support limited fishing effort. The majority of the angling effort occurs in the middle roaded section. That section is supplemented with hatchery catchable trout, though wild Redband Trout densities have remained consistent in that section over time.

Author:

John D. Cassinelli
Regional Fisheries Biologist

INTRODUCTION

The North Fork of the Boise River (NFBR) originates on the west side of the Sawtooth Mountain Range and flows in a southwesterly direction for approximately 80 km before joining the Middle Fork Boise River (MFBR). Ridgeline elevations at the head of the drainage are around 2,500 m, while the elevation at the confluence with the MFBR is approximately 1,060 m. The NFBR loses approximately 960 m in elevation over the 75 km from where it becomes a third-order stream to its mouth, dropping an average of 12.8 m per kilometer over that distance.

Similar to many of the streams and rivers in the Idaho Batholith, the NFBR is a relatively unproductive river with low levels of dissolved solids and nutrients, and a low conductivity. Historically, the drainages within the Idaho Batholith received marine-derived nutrients from the carcasses of returning anadromous fishes. However, anadromous fish were extirpated from the Boise Basin after the construction of numerous dams in the system, starting as early as 1909 with the completion of the Boise River Diversion Dam. The basin consists of granitic rocks and sand that result in shallow soil that is prone to high rates of erosion. Erosion is further amplified following wildfires and large portions of the basin were burned in the Rabbit Creek Fire in 1994 and the McNutt Fire in 2009.

Native game fish in the NFBR consist of Redband Trout *Oncorhynchus mykiss*, Bull Trout *Salvelinus confluentus*, and Mountain Whitefish *Prosopium williamsoni*. Additionally, the roaded section of the river is annually stocked with 10,000 catchable-sized hatchery Rainbow Trout from June through August.

Recreation along the NFBR is variable due to topography and access. The lower 15 km are in a steep, narrow, non-trailed canyon section. This section is moderately popular among floaters in the spring, but experiences little angling effort most of the year. The middle section (river kilometers 15-45) is roaded with numerous camping areas and one developed campground. This section of river receives the highest amount of recreation and angling effort. The upper 35 km are also remote consisting of a trailed canyon section immediately above the roaded section. The upper most portion of the basin is accessible via a primitive and long forest road (this road was washed out in the spring of 2017 and was reopened in the fall of 2018) or by flying into a remote airstrip at the U.S. Forrest Service's Graham Guard Station. As a result, the upper portion of the basin is also only moderately used for recreation. Despite varying access and remote setting, the most recent (2011) IDFG angler economic survey lists the NFBR as the second most economically significant fishery in Boise County (IDFG, unpublished data).

Fifteen NFBR sites (six in the lower canyon section, five in the middle roaded section, and four in the upper section) have been intermittently surveyed using snorkeling techniques since the late 1980s, with the most recent prior surveys being conducted in 2004. Following sampling in 2017, a strong correlation was observed between wild Redband Trout densities and the average flow across the three years prior to sampling. This finding corresponded with the findings of Copeland and Meyer (2011), who showed that stream flow three and four years previous to sampling, was the most important bioclimatic condition influencing Brook Trout *Salvelinus fontinalis* and Bull Trout densities in Idaho rivers. Given this apparent strong correlation between fish densities and flow patterns and knowing that 2017 was a record flow year, we decided to sample the NFBR for three consecutive years and compare observed densities across a short time period with varying flow conditions to see how much year to year variability in fish densities we might observe.

OBJECTIVES

1. Describe the distribution, relative abundance, and species composition of salmonids in the mainstem North Fork Boise River
2. Compare current populations trends of native game fish to historical estimates
3. Conduct surveys for three consecutive years (2017 – 2019) to better understand year to year variation in survey results

METHODS

During July and August of both 2017 and 2018, fifteen historic trend sites of various lengths were surveyed using entire-width snorkeling. We identified sites using historical accounts from previous sampling that included written descriptions, drawings, photos, and GPS coordinates. This allowed for reasonably precise relocation of sites. Prior to our 2017 sampling, all 15 sites had never been sampled in the same calendar year. Three of the 15 sites were sampled in the late 1980s, 10 of 15 in the late 1990s, and 13 of 15 in the early 2000s. All 15 sites were sampled from 2003 to 2004, which was the most recent sampling prior to 2017 (Table 21).

Sites were sampled with a crew of three completing an entire-width snorkel survey. Methods for conducting fish abundance surveys by snorkeling followed the methods outlined by Apperson et al. (2015). Most sites (12 of 15) were sampled starting at the bottom of the site and working in tandem upstream. However, three sites consisted of deep pools that were sampled by floating downstream (Table 22). Snorkelers counted all fish within their respective lanes and estimated lengths to the nearest inch. Species, counts, and visually-estimated length were recorded on PVC wrist cuffs by each snorkeler during the survey, then transcribed to a datasheet immediately after the completion of each survey. Also following the completion of each snorkel survey, staff measured and recorded individual site length, as well as quartile widths using a handheld laser rangefinder. All snorkelers conducting surveys in both 2017 and 2018 had previously attended Idaho Fish and Game's snorkel training course.

The NFBR has been historically stratified into three sampling sections (as outlined above). The lower section consists of six sites (Figure 42), the middle section five sites (Figure 43), and the upper section consists of four sites (Figure 44). Trends in relative abundance were compared by calculating species-specific density estimates for each site and comparing amongst years and river sections. Density was calculated as the count of each sport fish species divided by site area (site length multiplied by average width). Density was then corrected to fish per 100 m^2 to account for differences in area. Mean density for a particular site/year was calculated by dividing individual site catch by area first, then averaging densities, rather than by totaling catch and area and dividing. To further facilitate analysis, densities were also calculated for pooled fish lengths from 100 mm bins (0 ≥ 100 mm, 101 ≥ 200 mm", 201 ≥ 300 mm, and ≥ 301 mm).

RESULTS

Compared to 2017, wild Redband Trout densities increased in all three sample sections in 2018. Density increases were the lowest in the middle section (+18%), followed by the upper section (+66%), while the increase was greatest for the lower section (+115%) (Figure 45). Wild Redband Trout were distributed throughout the drainage and were observed in 14 of 15 sampling sites. Bluejay Creek was the lone sight where no trout were observed. In 2017, a total of 136 wild Redband Trout were observed and site-specific densities ranged from 0 to 3.68 fish/100 m^2. By comparison, in 2018, 249 total wild Redband Trout were observed (an increase of 83%) and site-specific densities ranged from 0 to 4.05 fish/100 m^2 (Table 22). Mean 2018 Redband Trout density across all sites was 1.77 fish/100 m^2 while overall densities in the lower, middle and upper sections were 2.81, 1.13, and 1.01 fish/100 m^2, respectively (Table 23).

Of the 249 observed Redband Trout, most (80%) were 250 mm or smaller, while 26 (10%) were observed in excess of 350 mm (Figure 46). The largest individual Redband Trout observed was 510 mm while the smallest was 50 mm. Redband Trout densities for 0 ≥ 100 mm, 101 ≥ 200 mm, 201 ≥ 300 mm, and ≥ 301 mm length categories were 0.18, 0.91, 0.52, and 0.18 fish/100 m^2, respectively. Overall Redband Trout densities continued to increase from the previous sampling period in 2003-2004 from 0.89 fish/100 m^2 to 1.77 fish/100 m^2 (Figure 47). While increasing, the 2018 Redband Trout densities were still 35% lower than the highest densities of 2.72 fish/100 m^2 observed in 2000-2001. However, the 2018 densities show an over four-fold increase from the densities observed in the late 1980s (Figure 47). A closer examination of Redband Trout densities by river section shows that densities in the middle section have remained fairly constant over time. However, densities in the upper river section have decreased. While Redband Trout densities were the lowest ever observed in the upper section in 2017, that density slightly rebounded in 2018. Still, the density of wild Redband Trout in the upper section remained 82% lower than the highest observed densities of the late 1990's (Figure 45). To the contrary, the increased wild Redband Trout densities we observed in the lower section in 2018 were the highest we've ever observed in that section, up 44% from the previously observed high in the early 2000's (Figure 45).

The other prominent game fish continues to be Mountain Whitefish. Similar to Redband Trout, Mountain Whitefish were widely distributed. Mountain Whitefish were present in 13 of the 15 sites surveyed. A total of 209 Mountain Whitefish were observed in 2018 (compared to 115 in 2017) and site-specific densities ranged from 0 to 5.38 fish/100 m^2 (Table 22). Mean Mountain Whitefish density across all sites was 1.37 fish/100 m^2 while overall densities in the lower, middle and upper sections were 1.26, 0.93, and 2.09 fish/100 m^2, respectively (Table 23). While values were all lower than the densities observed in the 2003-2004 surveys and have dropped substantially from the highest densities observed in 2000-2001, densities increased from 2017 for all three sections (Figure 48). There were a number of quality sized Mountain Whitefish observed. Of the 209 observed Mountain Whitefish, 42% were 350 mm or greater (Figure 49). The largest Mountain Whitefish observed was 530 mm, while the smallest observed was 75 mm.

Additional sportfish were observed less consistently. After observing no Bull Trout in 2017, five were observed during the 2018 surveys (Table 22). Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* densities were once again low (0.03 fish/100 m^2), following the highest ever observed in 2017 (0.14 fish/100 m^2) (Table 23). While a single Smallmouth Bass *Micropterus dolomieu* was observed in the lower canyon section in 2017 (the first ever observed in the NFBR), none were observed in 2018. Additionally, several native non-game fish species were also observed including Sculpin *Cottus sp.*, Northern Pikeminnow *Ptychocheilus oregonensis*, and sucker *Catostomus sp.* It's worth noting that with the exception of initial surveying efforts in the late 1980's, both Northern Pikeminnow and sucker densities remained substantially lower than previous survey periods (Table 23). Hatchery Rainbow Trout were observed at three middle section sites in 2018 as surveys were conducted shortly after hatchery stocking in that section. Due to the high variability in hatchery trout presence correlated with stocking and snorkel survey timing, there is little value in looking at trends in hatchery trout densities over time.

DISCUSSION

There remains a strong correlation in densities among the various species observed in the NFBR across sample periods as most densities were low during initial sampling in 1988-1989 and steadily increased over time, peaking during the 2000-2001 sampling period. Since that time, densities have steadily declined through 2017, returning back to similar levels observed in the late 1980's and 1990's. However, in 2018 densities rebounded and were similar to those observed in the late 1990's. All prominent species had the highest observed densities in the 2000-2001 sampling period. These trends in fish densities are interesting as the NFBR remains a relatively remote watershed with limited access and human disturbance. The most noteworthy events to occur in the basin during the sample period were large wildfires. However, these fires occurred in 1994 and 2009, and there is little evidence that either event had a strong influence on the trends observed in fish densities throughout the basin.

Because the NFBR remains mostly unaltered, the most variable factor in the river is annual flow. While there is not a flow gauge on the NFBR, there is a gauge on the MFBR below the confluence of the NFBR and the MFBR near Twin Springs, Idaho. Flow patterns at this gauge are influenced by flows from both rivers. However, given that both rivers drain from parallel, similar aspect basins, flow contributions from each river are highly correlated and this gauge is a suitable surrogate for flow patterns in the NFBR. While analyzing data from the 2017 surveys, we discovered that there appears to be a relationship between flow patterns in the lower MFBR and fish densities in the NFBR. The historic flow records for the MFBR gauge go back to well before the first snorkel sampling in the NFBR occurred in the summer of 1988. Average stream flow for the three years prior to sampling vs. Redband Trout densities showed a strong positive correlation (r^2 = 0.91). While this relationship was the strongest for Redband Trout, there were also strong correlations between flow and density for Bull Trout (r^2 = 0.62) and sucker species (r^2 = 0.71). Northern Pikeminnow (r^2 = 0.42) and Mountain Whitefish (r^2 = 0.15) densities were less correlated with MFBR flow in years prior to sampling. As noted earlier, these results are similar to those observed by Copeland and Meyer (2011). Outside of this study, there is little literature that evaluates seasonal variation in flow and densities of resident trout populations in a natural flowing river. The strong correlation observed between Redband Trout densities in the NFBR and flow in the lower MFBR is interesting and likely indicates that a combination of recruitment and fish movement are strongly correlated with river flow. A similar comparison of Redband Trout densities in the MFBR compared to average flow three years prior to sampling also showed a strong correlation (r^2 = 0.96; Figure 50). However, the MFBR has only been sampled three times with the last sampling coming in 2000. Because of these observed relationships, we decided to sample the NFBR across a three year window to better understand how these variations in flow might impact densities over a short period of time. The addition of the 2018 data to the flow/Redband density regression only slightly lowered the r^2 value to 0.84 and this relationship continues to be strong (Figure 50). We will sample the NFBR again in 2019 and if this relationship remains highly correlated, it will indicate that our infrequent (once per decade) snorkel sampling of rivers like the NFBR, MFBR, and South Fork Payette River may not be sufficient enough for trend monitoring as observed densities may simply be a product of the flow regime in the years leading up to sampling. Taking a multi-year sampling approach might be more appropriate.

Through 2017, the variation in species density over time was most pronounced for the upper section of the NFBR while the middle and lower river sections had shown a much lower level of variation. As noted in the 2017 report (Cassinelli et al. 2018), with the exception of 1996-1997 and 2000-2001 when upper section Redband Trout densities were 5.59 and 5.05 fish/100 m^2, respectively, all other densities across sample years and sections have only ranged from 0.14 – 1.95 fish/100 m^2. While these observations remain true, in 2018 the lower section had the highest wild Redband Trout densities ever observed in that section during these surveys. Given the relationship between flows and fish densities mentioned above, the densities of Redband Trout observed in the lower river were likely positively influenced by higher, cooler flows.

River section-specific Mountain Whitefish densities have been more variable than Redband Trout densities. Through 2017, all three sample sections had shown a steady decline in Mountain Whitefish densities. We noted in 2017 that this consistent decline was surprising given the overall health in Mountain Whitefish populations region-wide. However, Mountain Whitefish populations increased in all three sections in 2018. Mountain Whitefish in the NFBR had the lowest correlation with three-year prior average stream flow and density and I had previously hypothesized that perhaps because Mountain whitefish were a schooling species and because many of our sites were in large pools or at the mouth of cooler tributaries, that potentially we observed higher numbers in these locations when flows were lower. The increased densities across all three sample sections observed in 2018 correspond with lower sampling year flows compared to 2017 and may further support this hypothesis.

Historically, Bull Trout densities have been low in the NFBR. While no Bull Trout were observed in 2017, the five Bull Tout observed in 2018 were the third highest in the history of the surveys. Regardless, Bull Trout observations remain low and as we have noted in the past, this is most likely due to both low overall numbers and to migration patterns. Some of the Bull Trout that inhabit the NFBR migrate into the river from Arrowrock Reservoir. Previous radio tracking of these fish found that by August, most of these fish have reached the peak distance of their migrations and are spawning in the numerous tributaries of the NFBR (Flatter 2000).

In both 2017 and 2018, densities of the two most prominent non-game species, Northern Pikeminnow and suckers were well below those previously observed. However, densities of both did rebound slightly from 2017 to 2018 and again, this was likely related to flow conditions in years leading up to the surveys. Additionally, the presence of these two species in the NFBR are also likely strongly influenced by Arrowrock Reservoir as this reservoir is 11 miles downriver from the confluence of the NFBR and MFBR and supports large populations of both species (IDFG, unpublished data). Movement of Northern Pikeminnow and suckers into and out of the NFBR are likely correlated with not only flows, but numerous conditions in the reservoir, that can be highly variable from year to year.

Due to the extremely low conductivity in the NFBR, snorkeling remains the most effective means of estimating fish densities. However, snorkel estimates can be biased by variation in observers, visibility, and flow. As a means to help limit this bias, all snorkelers attended IDFG's snorkel training and sites were sampled at low flows during favorable weather conditions. Additional bias with historical sampling can occur due to variations in sight locations. While historic descriptions, photos, and GPS coordinates helped limit this, exact site replication is difficult due to variation in landmarks and river features between sample years. Additionally, sites themselves can change within reaches. This is especially true when sites occur at the mouths of tributaries, as do many of the sites on the NFBR.

Due to the limited accessibility and generally low densities of wild Redband Trout, especially of quality size, the upper and lower sections of the NFBR likely see limited fishing effort. The majority of the angling effort occurs in the middle roaded section. That section is stocked with 10,000 hatchery catchable trout annually and wild Redband Trout densities have remained consistent in that section over time. Continued stocking of sterile triploid hatchery Rainbow Trout in this section to supplement relatively low numbers of wild fish will continue to provide a fishery in this popular recreational section of river.

MANAGEMENT RECOMMENDATIONS

1. Sample the NFBR in 2019 to complete a three-year sampling cycle and use these three-year results to inform decisions on the frequency of sampling required to make informed inferences of long term trends in distribution, abundance, and species composition in both the NFBR and similar regional waters.

Table 21. All trend sites sample areas (m^2), by sample year and section, for the North Fork Boise River. Sample direction indicates whether sites were sampled working upstream (US) or downstream (DS).

River section	Sample site	Sample direction	Sample year 1988	1989	1996	1997	2000	2001	2003	2004	2017	2018
Upper	Silver Creek	US	/	/	/	/	546.0	/	/	485.8	560.0	630.0
	Graham Bridge	US	/	/	/	/	549.9	/	/	596.9	405.0	410.0
	Bluejay Creek	US	/	/	521.0	945.5	688.5	/	/	709.7	1036.0	1414.0
	Horsefly Creek	US	/	358.2	358.2	982.4	937.2	/	/	968.9	708.0	780.0
Middle	Deer Park	US	/	/	264.0	/	243.6	/	363.1	/	897.0	962.0
	Bear River	US	/	/	1389.8	/	1178.0	/	1266.3	/	1296.5	1344.6
	Crooked River	US	/	/	1086.0	/	1214.4	/	1071.0	/	1534.1	1534.1
	Black Rock	DS	2825.5	2825.5	1777.9	/	/	/	1710.5	/	1836.8	1834.0
	Rabbit Creek	US	3047.2	/	1293.2	/	1041.3	/	1316.9	/	1429.5	1425.0
Lower	Short Creek	US	/	/	1215.0	/	/	971.2	1245.5	/	1302.1	1102.4
	X1	DS	/	/	/	/	/	1008.7	835.5	/	1008.7	1001.0
	01 Sucker Hole	US	/	/	/	/	/	453.8	753.9	/	1109.7	1058.0
	X2	US	/	/	/	/	/	1054.5	1123.2	/	1098.5	1067.2
	French Creek	US	/	/	338	/	/	768.1	997.9	/	503.2	444.3
	96 Sucker Holle	DS	/	/	722	/	/	/	676.5	/	1003.8	1020.0

Table 22. Fish densities (fish/100 m^2) by species for each site sampled on the North Fork Boise River in 2018.

Site	Wild Redband Trout Length (mm) 0-100	100-200	200-300	>300	Wild Redband All	Bull Trout All	Westslope Cutthroat All	Mountain Whitefish All	Hatchery Rainbow Trout All	Northern Pikeminnow All	Sucker (var. spp) All
Silver Creek	0.32	0.79	0.32	0.00	1.59	0.00	0.00	0.00	0.00	0.00	0.00
Graham Bridge	0.24	0.73	0.73	0.24	1.95	0.00	0.00	1.71	0.00	0.00	0.00
Bluejay Creek	0.00	0.00	0.00	0.00	0.00	0.07	0.00	1.27	0.00	0.00	0.00
Horsefly Creek	0.00	0.13	0.26	0.13	0.51	0.00	0.00	5.38	0.00	0.00	0.00
Deer Park	0.21	1.04	0.21	0.00	1.46	0.00	0.00	0.73	1.04	0.00	0.00
Bear River	0.15	0.00	0.15	0.07	0.37	0.00	0.00	1.19	0.00	0.00	0.00
Crooked River	0.26	0.59	0.00	0.00	0.85	0.00	0.26	0.00	0.07	0.00	0.00
Black Rock	0.22	0.49	0.33	0.11	1.15	0.00	0.00	1.69	1.09	0.00	0.33
Rabbit Creek	0.00	0.77	0.84	0.21	1.82	0.00	0.00	1.05	0.00	0.00	0.00
Short Creek	0.00	0.82	0.73	0.18	1.72	0.00	0.00	1.00	0.00	0.18	0.00
X1	0.00	1.70	1.00	0.70	3.40	0.00	0.00	2.00	0.00	0.20	0.00
01 Sucker Hole	0.09	1.32	1.32	0.19	2.93	0.00	0.09	0.28	0.00	0.00	0.00
X2	0.09	1.78	0.66	0.19	2.72	0.00	0.00	1.31	0.00	0.00	0.00
French Creek	1.13	2.25	0.45	0.23	4.05	0.90	0.00	1.58	0.00	0.00	0.00
96 Sucker Hole	0.00	1.18	0.39	0.49	2.06	0.00	0.10	1.37	0.00	0.00	0.00
Totals	0.18	0.91	0.49	0.18	1.77	0.06	0.03	1.37	0.15	0.03	0.02

Table 23. Fish densities (fish/100 m^2) and total length (mm) by species for each river section across all sampling years of the North Fork Boise River.

Section		Wild Rainbow Trout length (mm)				Wild Rainbow	Bull Trout	Westslope Cutthroat	Mountain Whitefish	Hatchery Rainbow Trout	Northern Pikeminnow	Sucker (var spp)
	Year	0-100	100-200	200-300	>300	All	All	All	All	All	All	All
Upper	1989	0.00	0.28	0.56	0.00	0.84	0.31	0.36	1.29	0.42	0.48	1.74
	1996	0.52	3.53	2.83	0.99	7.86	0.45	0.14	0.84	0.81	0.14	0.00
	1997	0.26	1.60	1.14	0.31	3.31	0.21	0.16	0.05	0.00	0.05	0.00
	2000	0.93	2.18	1.59	0.36	5.05	1.03	0.08	6.64	0.04	0.00	0.00
	2004	0.16	0.88	0.37	0.00	1.40	0.11	0.07	3.22	0.00	0.00	0.00
	2017	0.04	0.20	0.21	0.16	0.61	0.00	0.04	1.92	0.00	0.00	0.00
	2018	0.14	0.41	0.33	0.09	1.01	0.02	0.00	2.09	0.00	0.00	0.00
Middle	1988	0.02	0.04	0.04	0.00	0.09	0.00	0.00	0.29	0.06	0.00	0.00
	1989	0.04	0.14	0.00	0.00	0.18	0.00	0.00	0.28	0.88	0.00	0.00
	1996	0.08	0.56	0.32	0.00	0.95	0.00	0.00	1.21	2.43	0.69	1.32
	2000	0.42	0.28	0.26	0.21	1.17	0.00	0.00	4.08	0.58	0.64	2.49
	2003	0.18	0.37	0.13	0.00	0.68	0.00	0.00	2.10	0.39	0.11	0.00
	2017	0.24	0.35	0.23	0.14	0.96	0.00	0.34	0.29	0.22	0.00	0.00
	2018	0.17	0.58	0.31	0.08	1.13	0.00	0.05	0.93	0.44	0.00	0.07
Lower	1996	0.00	0.05	0.09	0.05	0.19	0.00	0.00	1.19	0.14	1.12	3.36
	2001	0.37	0.74	0.74	0.10	1.95	0.00	0.00	1.63	0.00	0.37	3.60
	2003	0.12	0.31	0.26	0.03	0.71	0.02	0.02	1.55	0.00	0.07	0.15
	2017	0.28	0.43	0.45	0.14	1.31	0.00	0.05	0.27	0.00	0.02	0.02
	2018	0.22	1.51	0.76	0.33	2.81	0.15	0.03	1.26	0.00	0.06	0.00
All Sites	88-89	0.02	0.12	0.16	0.00	0.30	0.00	0.00	1.96	0.25	0.00	0.00
	96-97	0.10	0.77	0.54	0.12	1.52	0.07	0.03	0.95	1.21	0.63	1.52
	00-01	0.57	1.06	0.86	0.22	2.72	0.34	0.03	4.12	0.21	0.34	2.03
	03-04	0.15	0.48	0.24	0.01	0.89	0.04	0.02	2.18	0.13	0.07	0.06
	2017	0.20	0.34	0.31	0.15	1.00	0.00	0.14	0.72	0.07	0.01	0.01
	2018	0.18	0.91	0.49	0.18	1.77	0.06	0.03	1.37	0.15	0.03	0.02

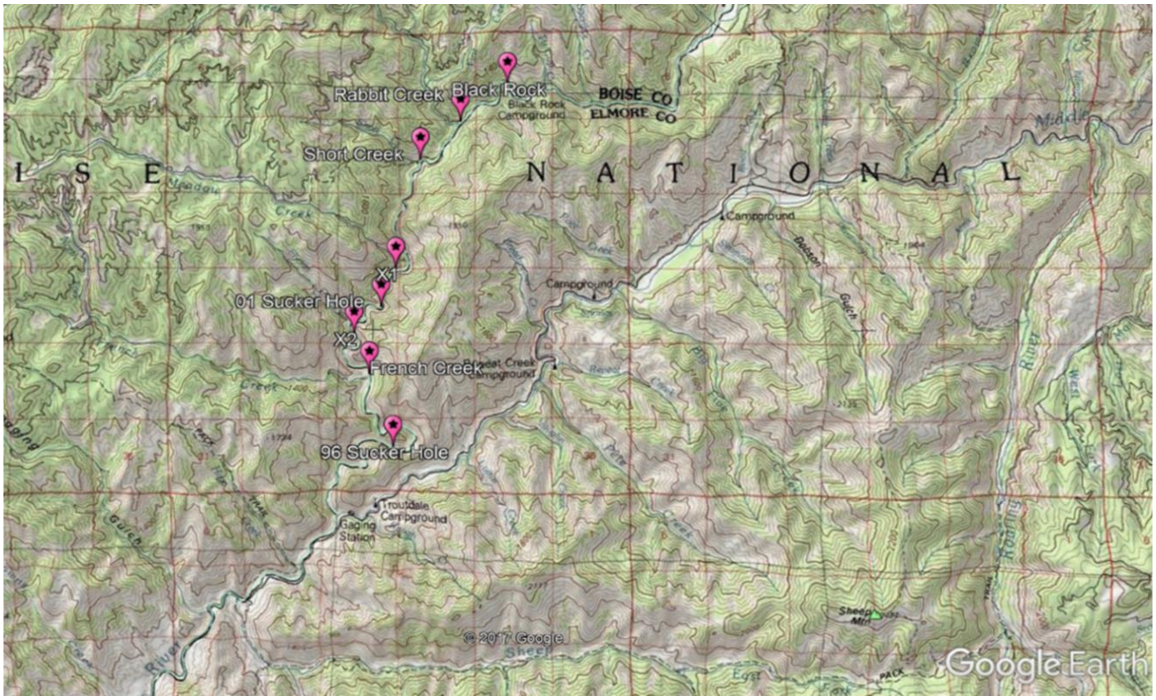


Figure 42. Locations of snorkeling sites sampled in the lower section of the North Fork Boise River during 2017 and 2018. Black Rock and Rabbit Creek sites are part of the middle sampling section but are included for reference.

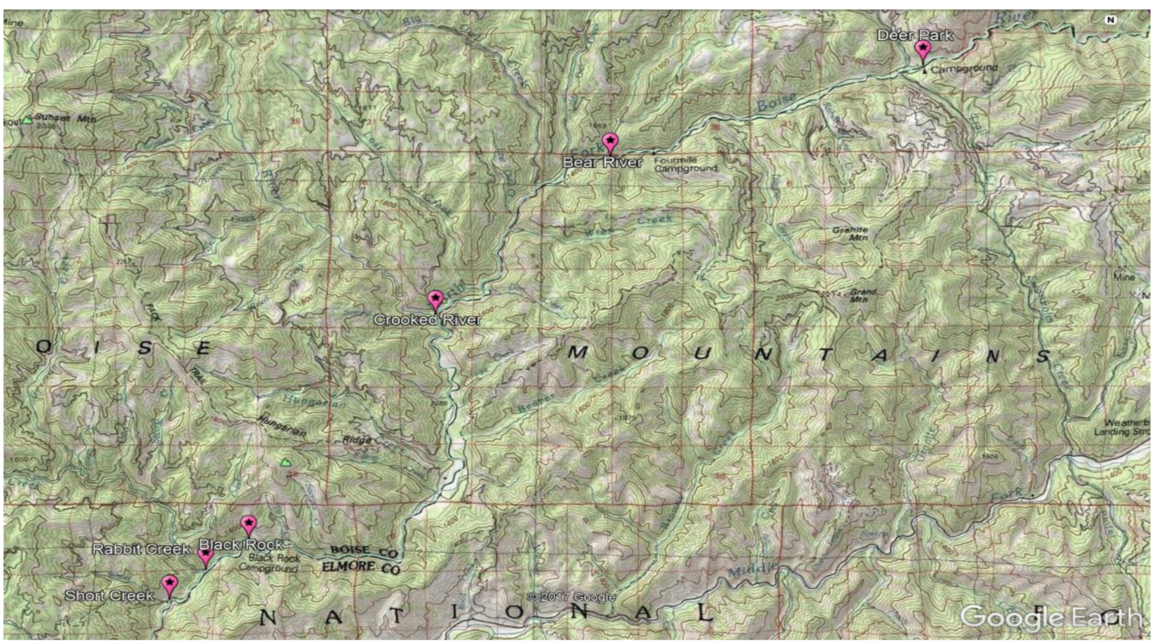


Figure 43. Locations of snorkeling sites sampled in the middle section of the North Fork Boise River during 2017 and 2018. Short Creek is part of the lower section but is included for reference.

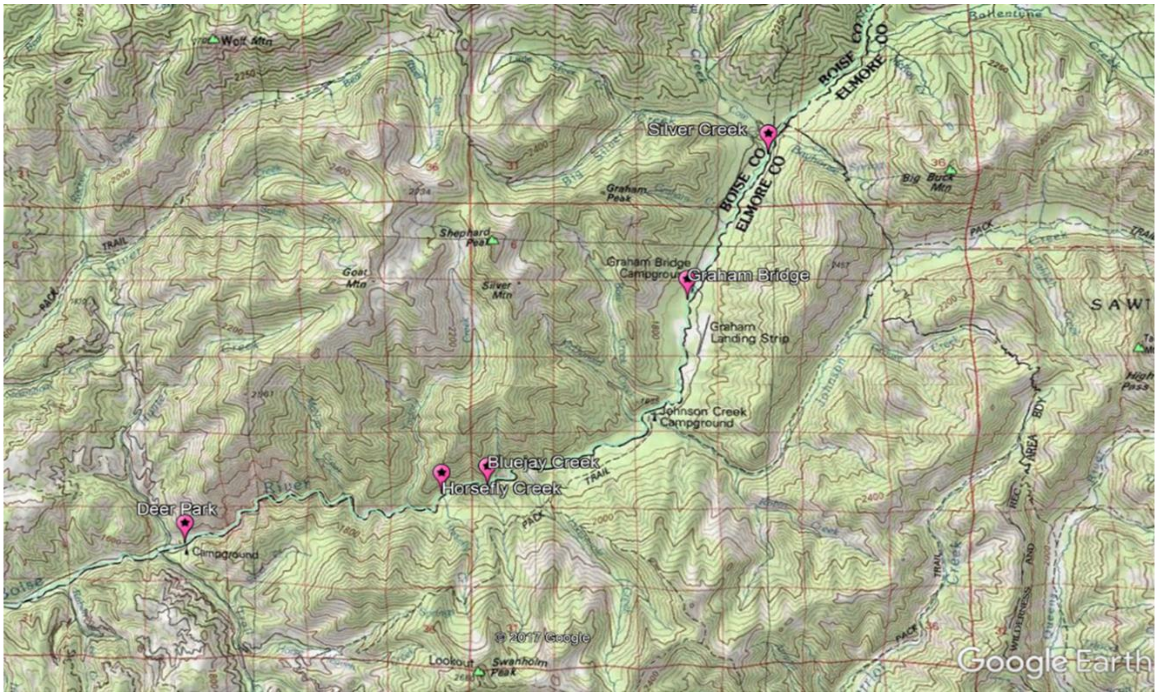


Figure 44. Locations of snorkeling sites sampled in the upper section of the North Fork Boise River during 2017 and 2018. Deer Park is part of the middle section but is included for reference.

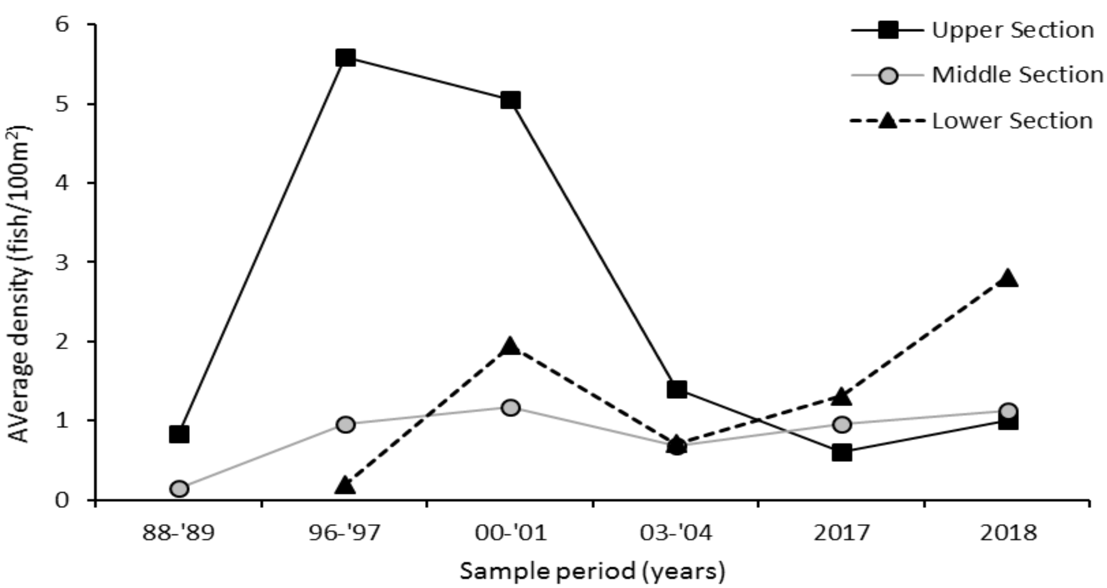


Figure 45. Average densities (fish/100m^2) of Redband Trout in the upper, middle, and lower sections of the North Fork Boise River among sample periods.

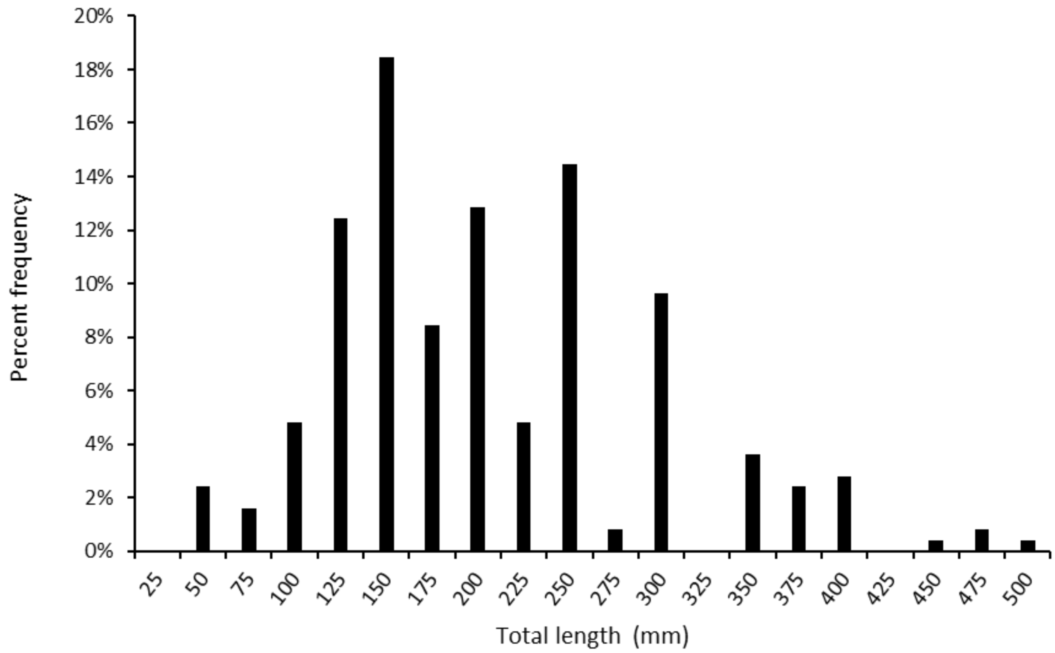


Figure 46. Length-frequency distribution of Redband Trout (n = 249) in the North Fork Boise River during 2018.

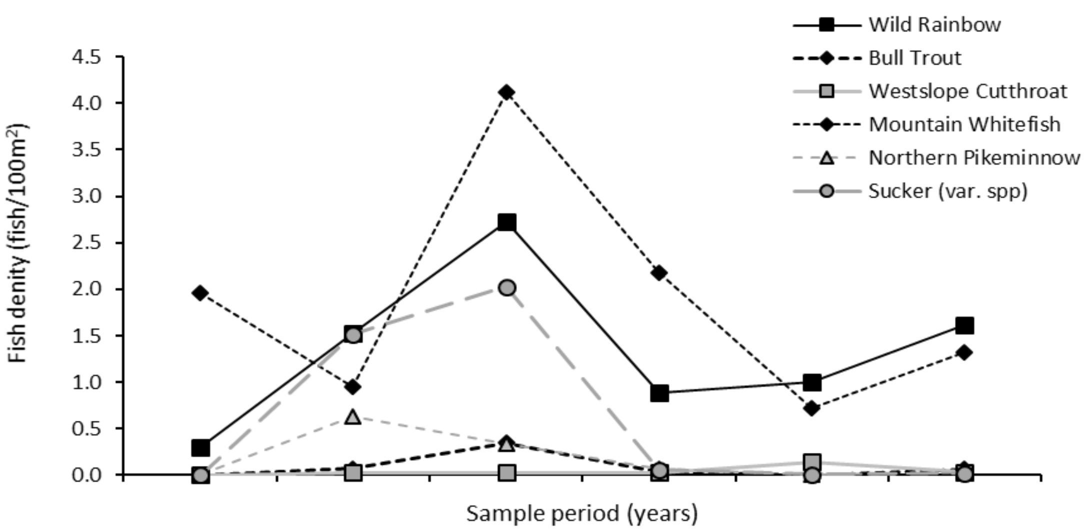


Figure 47. Densities (fish/100m^2) of all sportfish species (Redband Trout, Westslope Cutthroat Trout, Bull Trout, Mountain Whitefish) and the two most prominent non-game species (Northern Pikeminnow and suckers), among all sample periods in the North Fork Boise River.

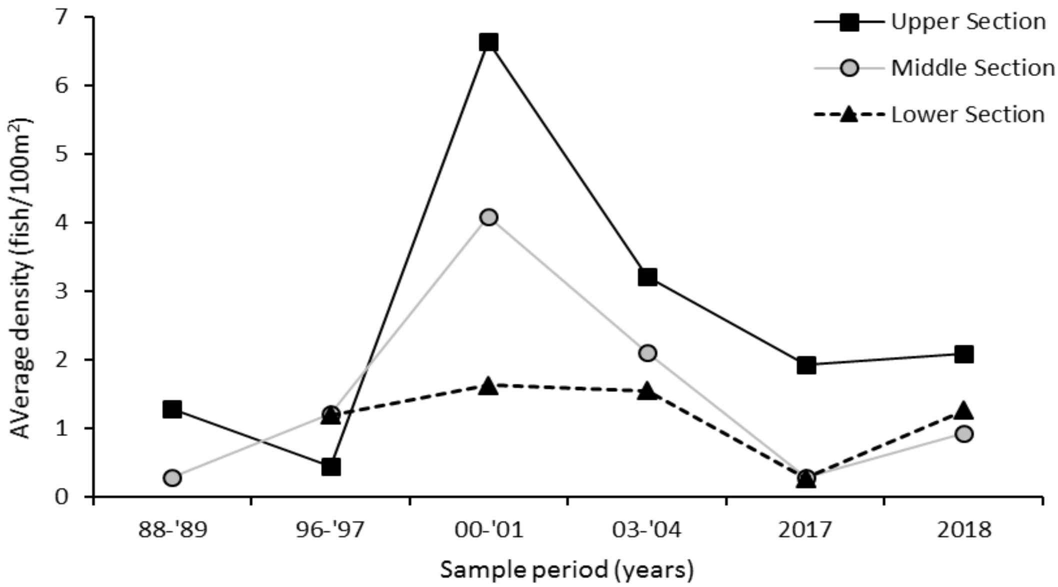


Figure 48. Average densities (fish/100m^2) of Mountain Whitefish in the upper, middle, and lower sections of the North Fork Boise River among sample periods.

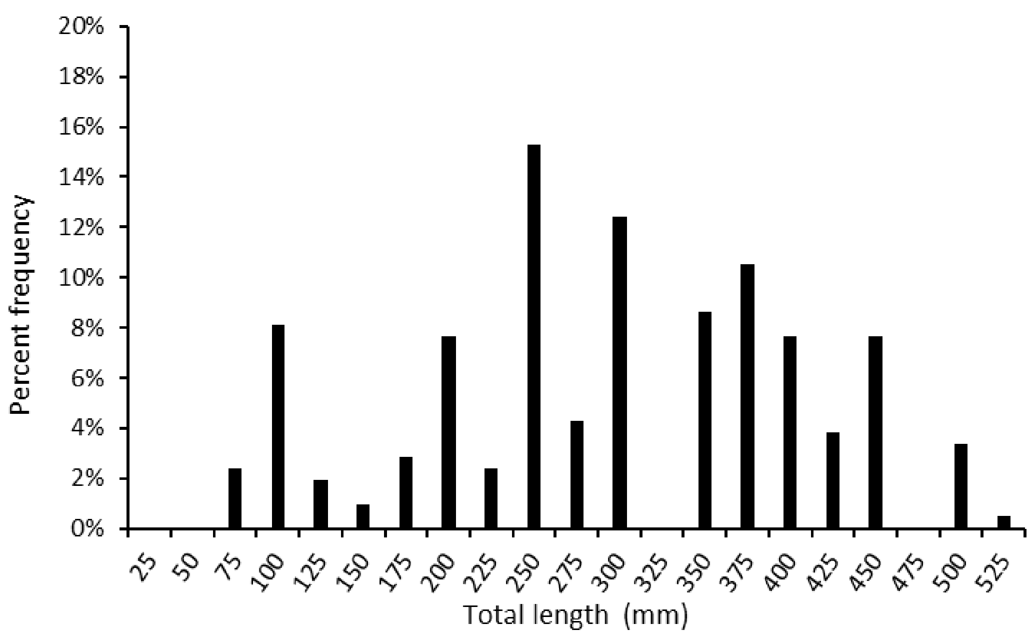


Figure 49. Length-frequency distribution of Mountain Whitefish (n = 115) in the North Fork Boise River during 2018.

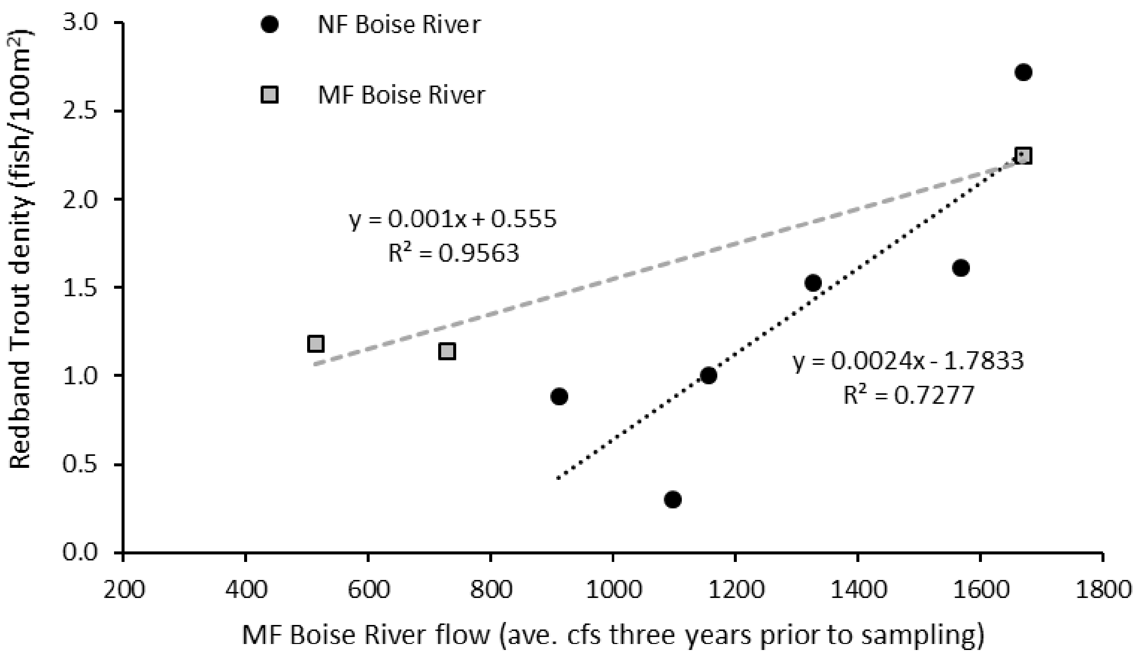


Figure 50. Redband Trout densities (fish/100m^2) for all sampling periods on the North Fork Boise River versus average stream flow for the three years preceding sampling. Flows are from the neighboring Middle Fork Boise River Twin Springs flow gauge.

STATUS OF MOUNTAIN WHITEFISH IN THE SOUTH FORK BOISE RIVER, LOWER BOISE RIVER, AND MIDDLE PAYETTE RIVER

ABSTRACT

Mountain Whitefish are one of the most abundant and widely distributed game fish in Idaho. Despite their high abundance, wide distribution, and potential large size, whitefish are not popular game fish for anglers. Despite their low popularity among anglers, whitefish remain an important native salmonid in Idaho's freshwater ecosystems. Trends in whitefish densities are often indicative of the suitability of habitat for other important cold-water salmonids. Starting in 2018, we began triennial sampling of whitefish on the South Fork Boise River (SFBR), Lower Boise River (LBR), and Middle Payette River (MPR) using single-pass electrofishing. The SFBR and LBR were sampled using wading entire-width canoe electrofishing, while the MPR was sampled using floating corridor raft electrofishing. In the SFBR, CPUE was 7.5 fish/min and ranged from 6.5 to 8.7. In the LBR, CPUE was 7.2 fish/min and ranged from 2.4 to 13.2. In the MPR, CPUE was 1.0 fish/min and ranged from 0.4 to 1.4. The SFBR, LBR, and MPR consist of drastically different habitats and conditions and as such, we saw differences in whitefish population structure. In the MPR, CPUE was much lower than in the other two waters. This was likely partially due to fewer fish being present, but also due to the different sampling methodology as capture efficiencies using the raft corridor sampling were likely lower than entire width canoe shocking. Three trend sites on each water will be monitored triennially to track long term trends in density and size structure.

Author:

John D. Cassinelli
Regional Fishery Biologist

INTRODUCTION

Mountain Whitefish *Prosopium williamsoni* (whitefish) are a native salmonid that are classified as a game fish in Idaho. Whitefish are one of the most abundant game fish in Idaho and widely disbursed in larger (greater than 15 m wide) lotic cold-water habitats throughout the state (Meyer et al. 2009). Despite their high abundance, wide distribution, and potential large size, whitefish are not a popular game fish among anglers. In a recent angler opinion survey, Idaho anglers ranked whitefish as one of their least favorite game fish to target. Out of all the game fish in Idaho, only tiger muskellunge ranked lower (IDFG, unpublished data). However, despite their low popularity among anglers, whitefish remain an important native salmonid in Idaho's freshwater ecosystems, especially mid-sized rivers. Trends in whitefish densities often indicate the suitability of habitat for other important cold-water salmonids.

Traditionally, whitefish densities were monitored in conjunction with systematic trout monitoring on both the South Fork Boise River (SFBR) and lower Boise River (LBR). However, starting with the 2014 triennial survey on the SFBR and the 2016 triennial survey on the LBR, whitefish were removed from the surveys in an effort to increase the capture efficiency of trout. Since that time, IDFG had not conducted any surveys targeting whitefish on either water. Additionally, whitefish have not been surveyed on the middle Payette River (MPR; between Black Canyon Reservoir and Banks, Idaho) since 2005. Due to IDFG's triennial electrofishing survey rotation on the SFBR and LBR, one out of every three years is an "open" year without any scheduled large river electrofishing surveys. Starting in 2018, Southwest Region staff decided to utilize this available year to sample whitefish on the SFBR, LBR, and MPR.

The SFBR downstream from Anderson Ranch Dam is a nationally-renowned tailwater fishery and was the first river section in the IDFG's Southwest Region to be managed under "Trophy Trout" regulations. This fishery is supported by populations of wild Rainbow Trout *Oncorhynchus mykiss* and Mountain Whitefish *Prosopium williamsoni*. Migratory Bull Trout *Salvelinus confluentus* are present at very low densities, and native nongame fish include Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow *Ptychocheilus oregonensis* and sculpin *Cottus sp*. are also present. Between Anderson Ranch Dam and its terminus into Arrowrock Reservoir, the SFBR is approximately 43 km long and consists of two recreationally distinct sections. The roaded section is approximately 16 km long and runs from Anderson Ranch Dam downstream to Danskin Bridge. The canyon section is approximately 27 km long and runs from Danskin Bridge downstream to Neal Bridge. The roaded section has a public road and access along the entire reach, resulting in the most angling effort. It is popular for both drift-boat and wade fishing. The canyon section has extremely limited access by foot or road because of high canyon walls and is accessible mostly by raft due to varying levels of whitewater in the section.

The LBR segment of the Boise River watershed begins at Lucky Peak Dam and continues for 103 km to its confluence with the Snake River near Parma, Idaho. The river flows through a variety of urban and agricultural settings and has been heavily affected by associated land and water uses (MacCoy 2004). Flows are regulated for both agricultural demands and flood control. Additionally, channel alteration has occurred throughout this reach. Higher than natural flows generally occur between April and September (mean = 48 m^3/s) and lower than natural flows occur between October and March (mean = 14 m^3/s). Furthermore, there are approximately 28 diversions along the Lower Boise River that supply water to various irrigation districts. There are approximately 14 major water inputs to the Lower Boise River, including drains or tributaries, water treatment facilities, and irrigation returns. The surrounding land and water use practices have resulted in significant impacts on water quality and biological integrity, including elevated sediment and nutrient levels, as well as increased water temperatures (MacCoy 2004). Fish composition shifts from primarily coldwater obligate species in the upper sections upstream of Glenwood Bridge, to a warmwater species assemblage near Middleton and downstream to the Snake River, with a transition zone in between. Species include Rainbow Trout *Oncorhynchus mykiss*, Brown Trout *Salmo trutta,* Mountain Whitefish *Prosopium williamsoni*, and sculpin *Cottus sp* in the upstream coldwater portion of the river. Warmwater species including Smallmouth Bass *Micropterus dolomieu*, Channel Catfish *Ictalurus punctatus*, Common Carp *Cyprinus carpio*, Redside Shiner *Richardsonius balteatus*, dace *Rhinichthys sp*, and sucker *Catostomus sp* are found more frequently in the lower portion downstream of Middleton, Idaho.

The MPR segment begins at the confluence of the South and North forks of the Payette River and runs roughly 42 km south then west to Black Canyon Reservoir. While the North Fork Payette and Deadwood River (South Fork Payette tributary) are both regulated by dams at Cascade and Deadwood reservoirs, the Middle Fork Payette and main South Fork Payette are both undammed and not significantly diverted for agriculture. As a result, the MPR has more of a hybrid hydrograph with a natural spring freshet as well as prolonged elevated mid to late summer flows resulting from delayed water delivery from the two large reservoirs. Because of the cold water reservoir deliveries in late summer, the MPR stays relatively cold, even during August and September. However, since the majority of the MPR's flows drain from the Idaho Batholith, the river is relatively unproductive with low levels of dissolved solids and nutrients, and a low conductivity. Historically, the drainages within the Idaho Batholith received marine-derived nutrients from the carcasses of returning anadromous fishes. However, anadromous returns to the MPR were extirpated after the construction of numerous dams in the system starting as early as the completion of Black Canyon Dam in 1924. Cold water species found in the MPR include Redband (Rainbow Trout) *Oncorhynchus mykiss*, Mountain Whitefish *Prosopium williamsoni*, and sculpin *Cottus sp*. Additionally, due to its proximity to Black Canyon Reservoir, numerous warmwater species including Smallmouth Bass *Micropterus dolomieu*, Channel Catfish *Ictalurus punctatus*, Common Carp *Cyprinus carpio*, Redside Shiner *Richardsonius balteatus*, dace *Rhinichthys sp*, and sucker *Catostomus sp* are also present in the MPR, epically in the lower portion.

METHODS

Whitefish catch-per-unit-effort (CPUE) was estimated at three sites on each river (Figure 51, 52, and 53) using single-pass electrofishing. Only whitefish were targeted during the surveys and CPUE was calculated as the number of whitefish captured per minute of electrofishing. On the SFBR and the LBR, fish were collected with a canoe electrofishing unit consisting of a 5.2-m Grumman aluminum canoe fitted with three mobile anodes connected to 15.2-m cables. The canoe served as the cathode. On the MPR, fish were collected with two 3.7 x 1.8 m Maravia® rafts each fitted with two pole-mounted anodes on the bow and cathodes hanging from both the starboard and port sides. Canoe or rafts carried the generator (3650 Watt Champion Power Equipment 100216), Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a live well for holding fish. Oxygen was introduced to the live well (2 L/min) through an air-stone. Pulsed direct current was used while settings were 25% duty cycle, 60 pulses per second, 350-450 volts, producing 1,500-2,500 watts.

Sites on the SFBR and LBR ranged from 350 to 440 m while sites on the MPR ranged from 1,000 to 1,250 m in length (Table 24). The SFBR was sampled in late September, 2018 while both the LBR and MPR were sampled in late October, 2018. Sites were selected visually considering proximity to sites sampled during other surveys (like triennial trout density estimates), accessibility, and habitat features. Riffles formed the upper and lower reach boundaries. Sites were sample during base winter flows. At the time of sampling, SFBR flow was approximately 9.3 m^3/s, LBR flow was approximately 7.7 m^3/s, and MPR flow was approximately 25.6 m^3/s. On both the SFBR and the LBR, crews consisted of twelve people. Three people operated the mobile anodes, one person guided the canoe and operated the safety switch and controlled the output. The remaining eight people were equipped with dip nets and captured stunned fish. On the MPR, a crew of four people conducted sampling. One person rowed each raft and controlled the output, while one person stood on the bow of each raft and netted stunned fish. Fish were processed at the end of each site. SFBR and LBR sites were sampled wading downriver and shocking the entire width of the river while MPR sites were sampled via corridor shocking with each raft covering one side of the river and targeting those areas that seemed best suitable for whitefish such as pool seams and moderately deep runs. All captured whitefish were measured for total length (mm) and a subset was weighed (g).

To characterize trends in size structure of Mountain Whitefish, proportional stock density (PSD) was calculated as described by Anderson and Neumann (1996). We used 150 mm as stock size and 200 mm, 250 mm, and 300 mm as quality, preferred, and memorable sizes following the recommendations of Gabelhouse Jr. (1984).

RESULTS

In the SFBR, a total of 527 whitefish were sampled across the three sites and CPUE for all three sites combined was 7.5 fish/min and ranged from 6.5 to 8.7 fish/m across sites (Table 24). Average length of all whitefish sampled was 377 mm and ranged from 279 – 540 mm. Site specific lengths are shown in Figure 54.

In the LBR, a total of 503 whitefish were sampled across the three sites and CPUE for all three sites combined was 7.2 fish/min and ranged from 2.4 to 13.2 fish/m across sites (Table 24). Average length of all whitefish sampled was 217 mm and ranged from 125 to 454 mm. Site specific lengths are shown in Figure 54.

In the MPR, a total of 117 whitefish were sampled across the three sites and CPUE for all three sites combined was 1.0 fish/min and ranged from 0.4 to 1.4 fish/m across sites (Table 24). Average length of all whitefish sampled was 226 mm and ranged from 120 to 348 mm. Site specific lengths are shown in Figure 54.

The PSD's for fish of quality, preferred, and memorable size varied considerably across sample waters and are outlined in Figure 55. The SFBR had PSD values greater than 95 for all three metrics while the LBR and the MPR had PSD-200 values less than 65. Additionally, while the MPR had a moderate PSD-300 value of 24, the LBR PSD-300 value was only six.

DISCUSSION

Because whitefish are widely distributed and require clean, cold water, monitoring their distribution and numbers not only provides managers with an index of whitefish population health, but also provides insight into habitat suitability for other cold-water fish species. Whitefish sampling intervals and methodologies at the three waters we surveyed in 2018 have been inconsistent over time. Our goal with this 2018 sampling was to establish trend sites on all three waters that would be sampled triennially going forward.

While combined in this chapter for ease and consistency of reporting, the SFBR, LBR, and MPR consist of drastically different habitats and conditions and as such, we saw differences in whitefish population structure. The CPUE of whitefish was very similar between SFBR and the LBR (7.5 and 7.2 fish/min). However, despite similar numbers of fish sampled, size structure between the two rivers was drastically different. The average length of whitefish sampled in the SFBR was 372 mm while the average length of whitefish sampled in the LBR was 217 mm. Additionally, whitefish size distribution across sample sites was consistent in the SFBR while the lower sampling sight on the LBR consisted of larger whitefish than the upper two sampling sites. While we did not collect structures to age fish, Meyer et al. (2009) created length-at-age curves for male and female whitefish from 20 populations in Idaho (including fish from the three waters we sampled). Based on the length-at-age relationships from that study, the majority of the fish we sampled in the SFBR were age-6 and older, while the majority of the fish sampled in the LBR were age-5 and younger. A large number of the fish sampled in the LBR were age-0 fish while we saw almost no age-0 fish in the SFBR. This is likely an artifact of where we shocked in the SFBR and doesn't indicate a whitefish recruitment issue.

In the MPR, CPUE was much lower than in the other two waters. This was likely partially due to fewer fish being present, but also due to the different sampling methodology. Capture efficiency using the raft corridor sampling was likely lower than entire width canoe shocking. The length distribution in the MPR was also quite different than the SRBR and LBR in that it was bimodal with about half the fish falling in the 140-180 mm range (likely age-0 fish) and half the fish in the 250-360 mm range (age-2 to age-7).

Going forward, both CPUE and length distribution will be monitored at the three sample sites on these three waters triennially. Managers will be able to track long term trends in catch and size structure of whitefish populations and gain valuable information on the trends in cold-water habitat quality within these river reaches. This is particularly true for the MPR where the river is not routinely sampled for other cold-water species beyond the scope of this monitoring.

MANAGEMENT RECOMMENDATIONS

1. Conduct single pass estimates in the three trend sites on each water during fall 2021 to assess abundance and length distributions of whitefish.

Table 24. Site length and catch-per-unit-effort (CPUE) for each of three sites sampled on the South fork Boise River, lower Boise River, and middle Payette River in the fall of 2018.

Water	Site	Site length (m)	No. whitefish caught	Shocking effort (hr:min:sec)	CPUE (fish/min)
South Fork Boise River	Upper	385	206	00:28:05	7.3
South Fork Boise River	Middle	415	124	00:19:07	6.5
South Fork Boise River	Lower	385	197	00:22:41	8.7
South Fork Boise River	***All***	***1185***	***527***	***01:09:53***	***7.5***
Lower Boise River	Upper	350	150	00:22:35	6.6
Lower Boise River	Middle	440	61	00:25:10	2.4
Lower Boise River	Lower	385	292	00:22:07	13.2
Lower Boise River	***All***	***1175***	***503***	***01:09:52***	***7.2***
Middle Payette River	Upper	1000	52	00:36:18	1.4
Middle Payette River	Middle	1250	16	00:38:46	0.4
Middle Payette River	Lower	1250	49	00:41:49	1.2
Middle Payette River	***All***	***3500***	***117***	***01:56:53***	***1.0***

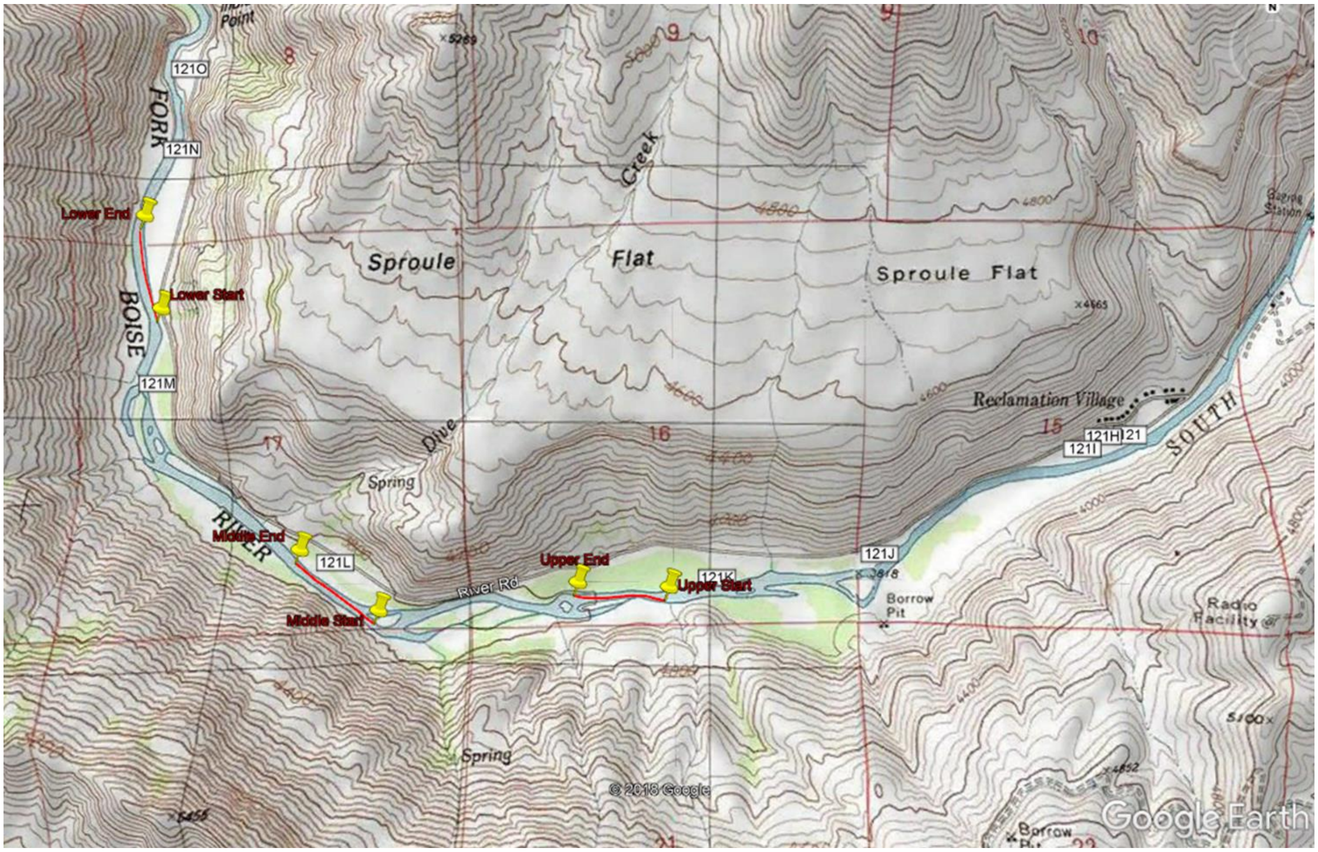


Figure 51. Upper, middle, and lower sites (along with their upper and lower boundaries) sampled for Mountain Whitefish on the South fork Boise River in September, 2018.

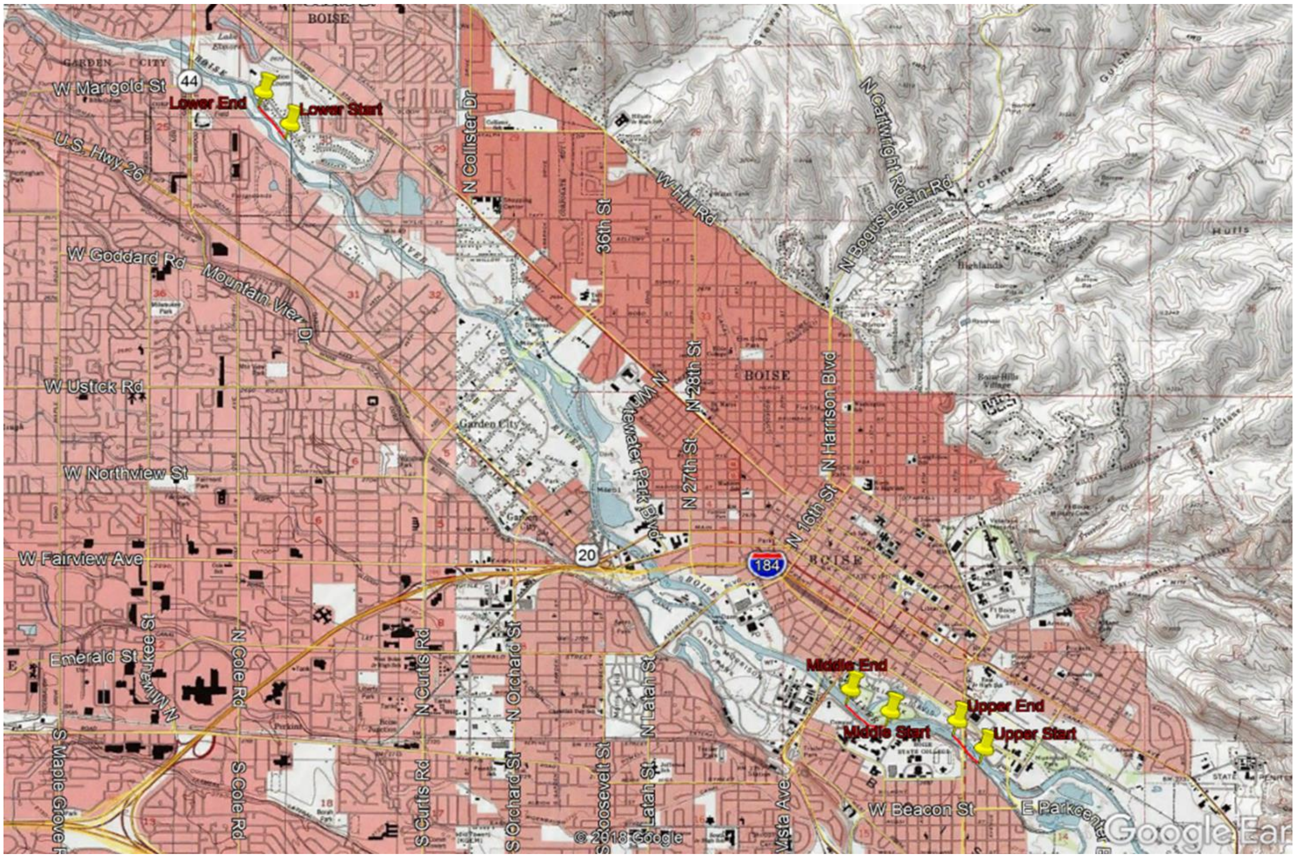


Figure 52. Upper, middle, and lower sites (along with their upper and lower boundaries) sampled for Mountain Whitefish on the lower Boise River in October, 2018.

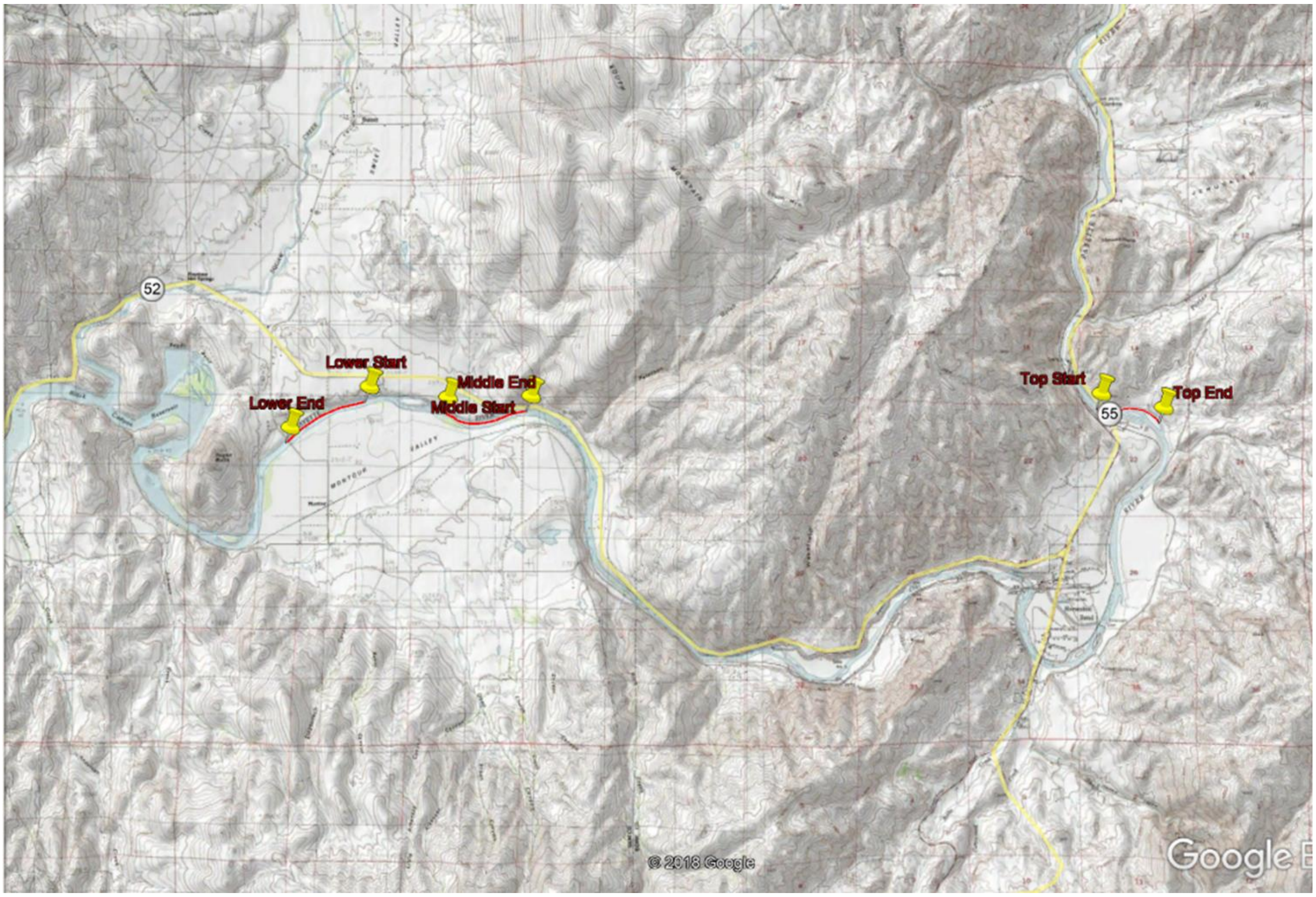


Figure 53. Upper, middle, and lower sites (along with their upper and lower boundaries) sampled for Mountain Whitefish on the middle Payette River in October, 2018.

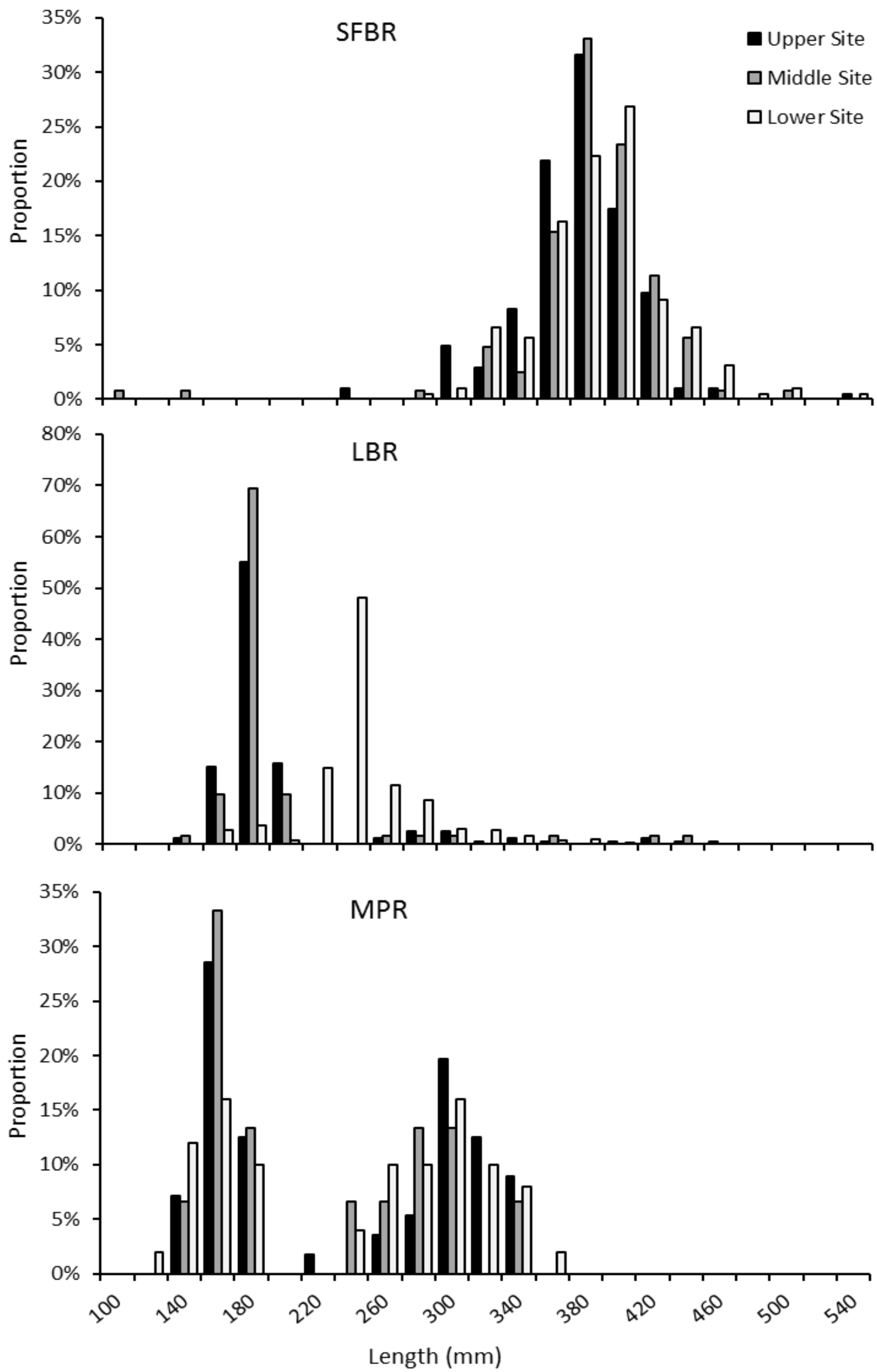


Figure 54. Length-frequency proportions of Mountain Whitefish sampled at upper, middle, and lower sample sites in the South Fork Boise River (SFBR), lower Boise River (LBR), and middle Payette River (MPR).

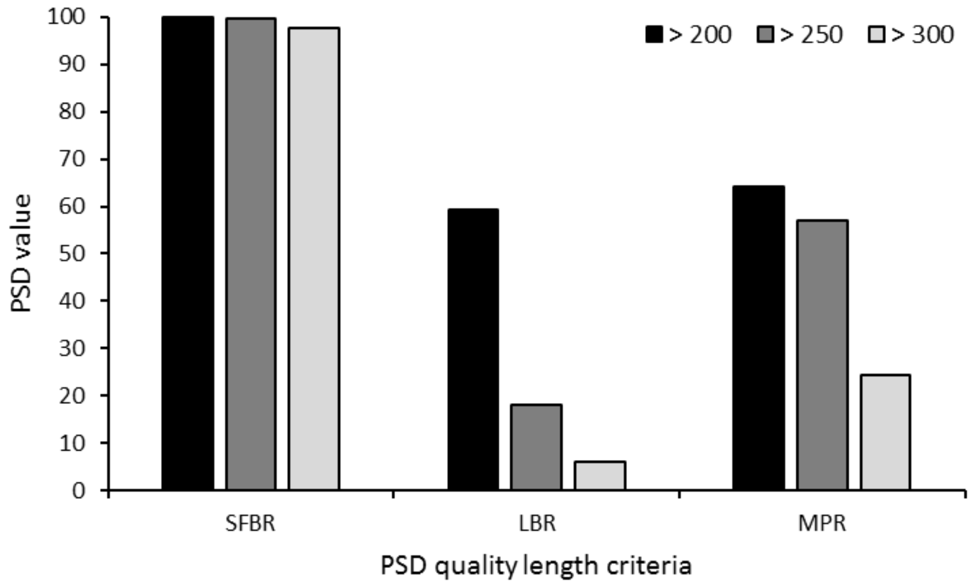


Figure 55. Proportional stock density (PSD) of Mountain Whitefish from the South Fork Boise River, lower Boise River, and middle Payette River. Stock length was 150 mm and proportions were generated for fish of quality (200 mm), preferred (250 mm), and memorable (300 mm) size.

LONG-TERM MONITORING OF REDBAND TROUT POPULATIONS IN THE OWYHEE RIVER DRAINAGE

ABSTRACT

During 2018, the Idaho Department of Fish and Game continued population and trend monitoring for interior Redband Trout *Oncorhynchus mykiss gairdner* within the Idaho portion of their distribution. As part of that effort, three tributaries (Rail, South Mountain, and South Boulder creeks) were sampled in the Jordan Creek watershed (HUC 4) in 2018. Utilizing a systematic sampling design, 23 sites were selected to be sampled among the three tributaries. A total of 22 sites were sampled, of which 13 sites were dry and nine sites were wet. Redband Trout were observed in all nine of the wet sites and the percent occupancy for Rail, South Mountain, and South Boulder creeks were estimated to be 0%, 29%, and 70%, respectively. Density estimates for sites, which contained Redband Trout, ranged from 8.4 to 65.1 fish/100 m^2. Overall, capture efficiencies were high, ranging from 82% to 98%. The 2018 survey provided baseline information for Rail Creek. The Redband Trout found in South Mountain and South Boulder creeks are mid-density populations and appear stable when compared to previous surveys.

Author:

Michael P. Peterson
Regional Fishery Biologist

INTRODUCTION

Redband Trout *Oncorhynchus mykiss gairdneri* are native to all major river drainages in Southwestern Idaho. Within this large and diverse geographical area, Redband Trout have adapted to a variety of stream habitats, including those of montane and desert areas. Some controversy has existed regarding whether adaptation to these disparate habitats has led to speciation at some level. In 1997, Redband Trout that reside in desert locales were petitioned for listing under the Endangered Species Act (ESA; USFWS 2000), under the assumption that they could be considered a separate subspecies. The petition was denied. Since that time, additional research has indicated that only one species of resident stream dwelling Redband Trout may exist in Southwest Idaho (Cassinelli 2008). Regardless of species designations, it is important to monitor Redband Trout population status across their full distribution. Population status of the Redband Trout from montane habitats has been extensively studied in Southwestern Idaho. However, due to remoteness and little angling interest (Schill et al. 2007), Redband Trout from desert habitats have received less attention. These habitats include tributaries of the Bruneau, Owyhee, and Snake River drainages most often in headwater areas. As these populations are near the southern extent of their range and water temperatures are projected to increase, it has become more important to monitor these populations closely (Narum et al. 2010).

Since the 1997 petition for listing was denied, a considerable amount of effort has been placed on determining the current species distribution and developing conservation strategies to ensure persistence. Zoellick et al. (2005) completed a long-term assessment of Redband Trout distribution, density, and size structure. This assessment compared Redband Trout population characteristics at 43 sites within the Bruneau, Owyhee, and Snake river drainages from 1993-2003 to data collected at the same sites during 1977-1982. In 2012, biologists conducted a rangewide assessment, which relied heavily on available data and the expert opinion to identify the current distribution (Muhlfeld et al. 2015). The assessment identified a framework to develop rangewide conservation measures and to provide structure for long-term species persistence, which was developed in 2016 (IRCT 2016). Specifically within the Conservation Strategy, the Idaho Department of Fish and Game (IDFG) agreed to continue population and trend monitoring within Redband Trout distribution. In 2018, Redband Trout surveys were conducted in three tributaries within the Jordan Creek watershed (a tributary of the Owyhee River) located in the high desert environs of Southwest Idaho.

METHODS

During 2018, sample sites were determined following the systematic sampling design described in Peterson et al. (2018), which allowed for approximately five percent of total stream length to be sampled. During 2018, Rail, South Mountain, and South Boulder creeks were surveyed within the Jordan Creek watershed (HUC 4). A total of 23 sites were selected within the three tributaries. GPS site coordinates were added to the survey map to identify land ownership. During 2018, 65% of the selected sites were located on private property. Private property access was obtained for all sites. One site was not sampled due to time constraints.

Using multiple-pass depletion methods, fish population characteristics were estimated at all sites. Block nets were installed at the upstream and downstream end of each transect. Fish were collected with a Smith Root backpack electrofisher (Model LR-24) and a two- or three-person crew. Captured Redband Trout were held in small buckets and transferred to a livewell placed downstream of the site, where they were identified to species and measured for total length (± 1 mm). Any non-game fish captured were identified to species, and visually categorized as sparse

(1-10), many (10-50), or abundant (>50). The number of passes completed depended on catch during the first pass. If Redband Trout catch in the first pass was less than five, sampling was terminated. If more than five Redband Trout were sampled, a second pass was completed. If catch remained relatively high in subsequent passes (>25% of the previous pass) additional passes were completed. In addition, herpetofauna were identified visually to species and recorded as eggs, larval form, juvenile, or adult.

A total of 22 sites were sampled in September of 2018 within three tributaries of the Jordan Creek watershed (Figure 56). Population estimates and 95% confidence bounds were calculated using MicroFish 3.0 (Van Deventer 2006). Due to the potential for size-related catchability differences, population estimates were calculated for two strata: (1) trout less than 100 mm, and (2) trout greater than or equal to 100 mm, then summed. If all sampled fish were collected in the first pass, maximum likelihood estimates could not be developed and capture efficiency was assumed 100%. At two sites, a single pass was completed where more than five fish were sampled. At these sites (SMC 7 and SBC 3), population estimates were developed by regressing the number of fish captured in the first pass against the final population estimates from the multiple pass sites (Meyer 2000). To determine the percent occupancy for each stream, the number of sites with Redband Trout observations was divided by the number of sites surveyed (wet and dry combined). Confidence intervals for mean density and the percent occupancy were calculated using an $\propto = 0.05$. Two sites sampled in 2018 (SMC7 and SBC 10) were used for comparisons to trend sites established in the late 1970's (Zoellick et al. 2005). These sites are not directly comparable but are both located within a half of a kilometer of the original sites. Genetic fin clips were taken to identify whether introgression has occurred with non-native Rainbow Trout.

RESULTS

Redband Trout were observed within two tributaries that were sampled in 2018. Redband Trout total catch ranged from 0 to 124 trout per site. The mean density of Redband Trout for all surveyed sites was 16.4 ± 10 trout/100 m^2 (mean ± 95% CI). The mean density at occupied sites was 40.0 (± 14) trout/100 m^2. Densities, for all fish sizes at occupied sites, ranged from 8 (± 1) to 65 (± 2) trout/100 m^2 (Table 25). A total of 585 Redband Trout were sampled in 2018, of which 229 (44%) were less than 100 mm, while 294 (56%) were greater than 100 mm. Capture probabilities were relatively high and ranged from 0.63 to 1.00. The mean capture probability was 0.87 ± 0.14 and 0.89 ± 0.10 for fish <100 mm and ≥100 mm, respectively. Length frequency data are presented in Figure 57. Bridgelip Sucker *Catostomus columbianus* was the only other native species observed within the sampled tributaries. Nonnative species were not observed during 2018.

A total of 13 of the sampled sites were dry in 2018 (Table 26). Redband Trout were observed in all wet sites (n = 9). The percent occupancy was calculated at 0% (2 – 54%; 95% CI), 29% (5 – 70%), and 70% (35 – 92%) for Rail, South Mountain, and South Boulder creeks, respectively (Table 26). Sampling occurred on approximately five percent of each stream.

DISCUSSION

Sampling was continued within the Jordan Creek HUC 4, using the systematic sampling methodology initiated in 2016, at three tributaries: Rail, South Mountain, and South Boulder creeks. The systematic sampling will allow for the development of specific tributary or basin wide abundance estimates. Muhlfeld et al. (2015) recommended this type of rigorous sampling design.

Sampling did not occur at the same locations as in past surveys (Kozfkay et al. 2010); however, the South Mountain and South Boulder creeks populations appear to be stable or slightly increasing over time with mid-range densities. The densities observed in South Mountain and South Boulder creeks also validated information presented in the 2012 assessment with population densities ranging from 36 to 100 fish/100 m^2. Similar to prior surveys, I did not identify any non-native species in 2018 in these tributaries. Future surveys should continue to monitor for the presence/absence of non-native species.

Survey results indicated that Rail Creek survey sites were dry in 2018. Water and Redband Trout were observed in a spring directly above the upper-most survey site in the drainage. Anecdotal information (e.g. local rancher) suggests that seasonal connectivity may occur within the drainage; however, perennial Redband habitat may only be present near the spring directly above South Mountain Road. The genetic status of Redband Trout sampled in South Mountain and South Boulder creeks remain unknown, at the time of this report. Genetic samples were collected from both tributaries where Redband Trout were sampled, but results from analyses were not yet available.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor Redband Trout distribution and abundance within the Jordan Creek HUC 4, using the systematic sampling design developed in 2016.
2. Continue monitoring for presence/absence of non-native species within the Jordan Creek HUC 4.
3. Identify a habitat improvement project that would benefit Redband Trout within the Jordan Creek basin.

Table 25. Site specific population (N), capture probability, and density estimates for Redband Trout of all sizes, less than 100 millimeters (mm) and greater than or equal to 100 mm in total length. Lower (LCL) and upper (UCL) confidence limits were calculated with an ∝ = 0.05 for the population and density estimates.

Site #	Stream name	Run 1	Run 2	Total	*N*	LCL	UCL	Confidence range (%)	Capture probability	Density #/100m^2	LCL	UCL
						ALL						
SMC 7	South Mountain Creek	56	-	-	65	59	71	-	-	58.6	0.0	64.0
SMC 8	South Mountain Creek	63	12	75	77	73	81	5.2	0.82	42.5	40.3	44.8
SBC 2	South Boulder Creek	80	2	82	82	82	82	0.0	0.98	20.9	20.9	20.9
SBC 3	South Boulder Creek	55	-	-	64	58	70	-	-	28.3	25.7	31.0
SBC 5	South Boulder Creek	51	11	62	64	59	69	7.8	0.81	41.0	37.8	44.2
SBC 7	South Boulder Creek	57	4	61	61	60	62	1.6	0.94	38.0	37.3	38.6
SBC 8	South Boulder Creek	15	2	17	17	16	18	5.9	0.90	8.4	7.9	8.9
SBC 9	South Boulder Creek	105	17	122	124	120	128	3.2	0.85	65.1	63.0	67.2
SBC 10	South Boulder Creek	46	9	55	56	52	60	7.1	0.83	57.9	53.7	62.0
						< 100 mm						
SMC 7	South Mountain Creek	31	-	-	39	31	47	-	-	35.1	27.9	42.3
SMC 8	South Mountain Creek	49	7	56	56	54	58	3.6	0.89	30.9	29.8	32.0
SBC 2	South Boulder Creek	19	2	21	21	20	22	4.8	0.91	5.4	5.1	5.6
SBC 3	South Boulder Creek	8	-	-	9	1	17	-	-	4.0	0.4	7.5
SBC 5*	South Boulder Creek	-	-	-	-	-	-	-	-	-	-	-
SBC 7	South Boulder Creek	21	1	22	22	22	22	0.0	0.96	13.7	13.7	13.7
SBC 8	South Boulder Creek	6	0	6	6	6	6	0.0	1.00	3.0	3.0	3.0
SBC 9	South Boulder Creek	34	14	48	55	42	68	23.6	0.63	28.9	22.0	35.7
SBC 10	South Boulder Creek	30	7	37	38	34	42	10.5	0.80	39.3	35.1	43.4

*No length data collected for the site; therefore, size specific estimates were not calculated.

Table 25 (continued)

Site #	Stream name	Run 1	Run 2	Total	*N*	LCL	UCL	Confidence range (%)	Capture probability	Density #/100m^2	LCL	UCL
						$\geq$ 100 mm						
SMC 7	South Mountain Creek	25	-	-	30	21	39	-	-	27.0	18.9	35.1
SMC 8	South Mountain Creek	14	5	19	20	15	25	25.0	0.73	11.0	8.3	13.8
SBC 2	South Boulder Creek	61	0	61	61	61	61	0.0	1.00	15.6	15.6	15.6
SBC 3	South Boulder Creek	47	-	-	57	48	66	-	-	25.2	21.2	29.2
SBC 5*	South Boulder Creek	-	-	-	-	-	-	-	-	-	-	-
SBC 7	South Boulder Creek	36	3	39	39	38	40	2.6	0.93	24.3	23.6	24.9
SBC 8	South Boulder Creek	9	2	11	11	9	13	18.2	0.85	5.4	4.4	6.4
SBC 9	South Boulder Creek	71	3	74	74	73	75	1.4	0.96	38.8	38.3	39.4
SBC 10	South Boulder Creek	16	2	18	18	17	19	5.6	0.90	18.6	17.6	19.6

*No length data collected for the site; therefore, size specific estimates were not calculated.

Table 26. Stream specific statistics for sites surveyed during 2018 which include number of sites selected and sampled, the percent of the stream sampled, the number of sites that were dry and wet, the number of sites Redband Trout were observed, and the percent occupancy for the stream. Lower (LCL) and upper (UCL) confidence limits were calculated with an ∝ = 0.05 for the percent occupancy estimates.

Stream name	Sites selected	Sites sampled	% of stream sampled	Dry sites	Wet sites	# of sites Redband Trout were observed	% Occupancy	LCL	UCL
Rail Creek	5	5	4.6%	5	0	0	0.0%	2.0%	54.0%
South Mountain Creek	8	7	4.5%	5	2	2	28.6%	5.1%	69.7%
South Boulder Creek	10	10	4.6%	3	7	7	70.0%	35.4%	91.9%

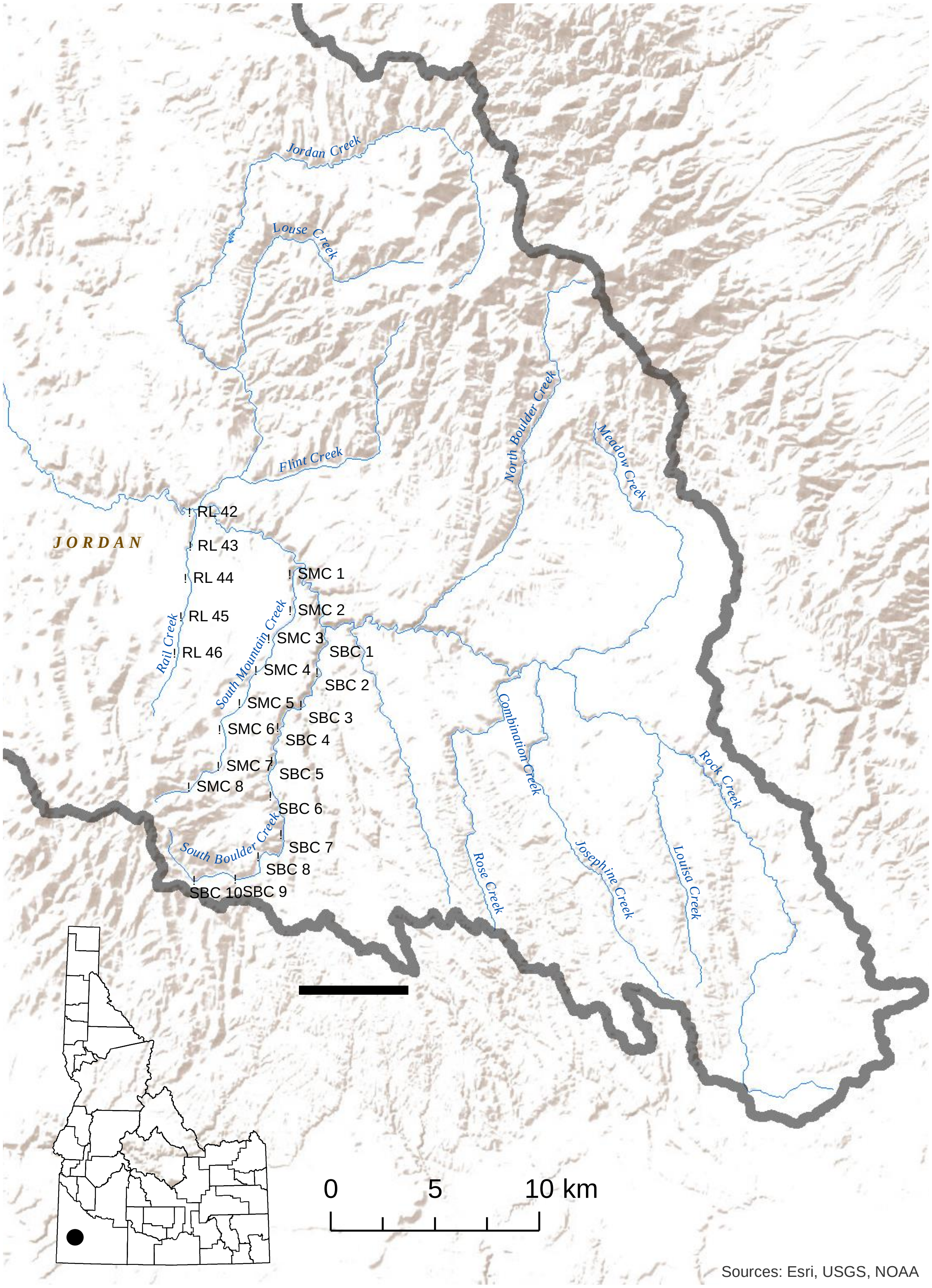
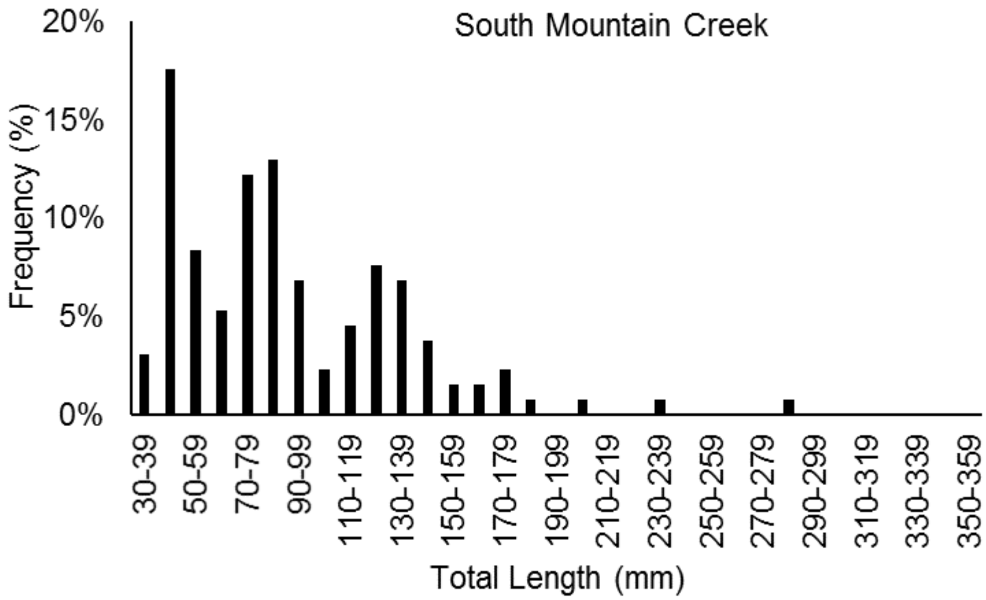


Figure 56. Location of sample sites within the Jordan Creek drainage surveyed to assess Redband Trout populations in 2018.



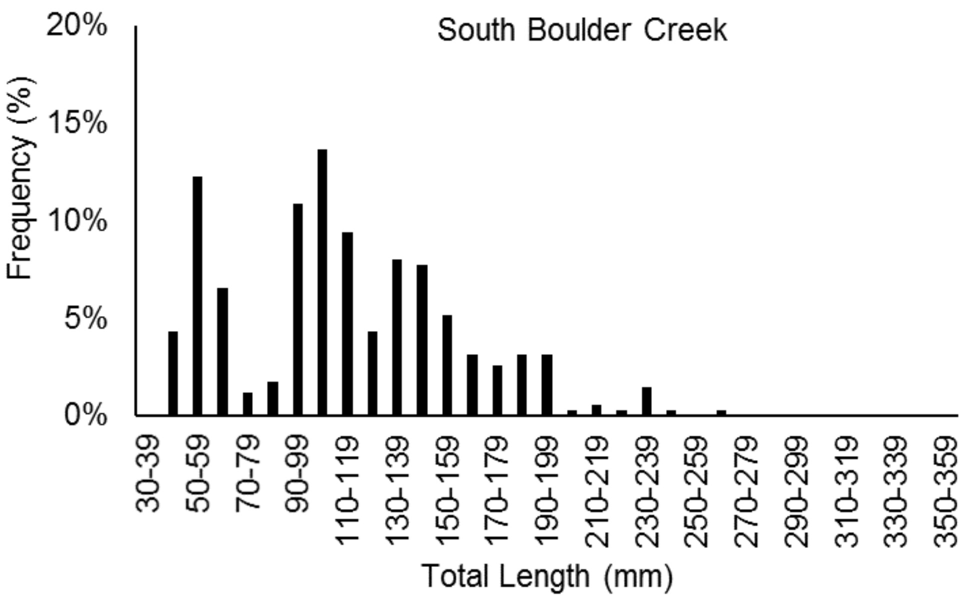


Figure 57. Length-frequency histogram for Redband Trout sampled in South Mountain Creek (n = 131) and South Boulder Creek (n = 351) during 2018 electrofishing surveys.

LOWER PAYETTE RIVER FISH POPULATION SURVEYS

ABSTRACT

Both fish population and creel data are lacking for the lower Payette River between Black Canyon Dam and the Snake River. Previous sampling was performed in 2009 to establish baseline fish community data throughout this lower reach. In 2013, the Payette River was sampled in response to the recent draw down of Black Canyon Dam and the associated sedimentation event below. The 2018 survey marked the third standardized survey using jetboat electrofishing gear to sample the fish community. During the 2018 standardized survey, 1,115 fish were collected, comprising 14 different species. Total CPUE was 262 f/h (± 37; 90% CI) and continued to decline from the 2013 survey. Mountain Whitefish made up 48% of the total catch, followed by Largescale Sucker (33%), Northern Pikeminnow (5%), and all other species comprised 14%. Smallmouth Bass relative abundance decreased significantly between 2009 and 2018 from 56 f/h (± 14) to 10 f/h (± 4). A similar change in relative abundance was observed for Channel Catfish as well.

Author:

Michael P. Peterson
Regional Fishery Biologist

INTRODUCTION

Historically, the lower Payette River acted as a migratory corridor for anadromous fish runs. Completion of Black Canyon Dam in 1924 extirpated these runs by blocking access to spawning habitats. Additional dam construction downstream in the Snake River and subsequent fish introductions have fundamentally altered the fish community in the lower Payette River. Formerly, native salmonids, cyprinids, and catostomids were the most common species present. Presently, a large proportion of the fish community consists of non-native ictalurids, Smallmouth Bass *Micropterus dolomieu*, and Common Carp *Cyprinus carpio*, similar to other large rivers in Southwest Idaho. Until 2009, very little fish population or creel data had been collected from the lower Payette River. While some Rainbow Trout *Oncorhynchus mykiss* and Mountain Whitefish *Prosopium williamsoni* are present, sport fishing in the river focuses primarily on Smallmouth Bass and Channel Catfish *Ictalurus punctatus*. In an effort to gain a better understanding of the composition and distribution of fish within the lower Payette River, a survey was conducted in July 2009, which provided baseline data for the reach (Butts et al. 2011).

Black Canyon Diversion Dam is a 183-foot concrete diversion dam located approximately 8 km upstream of Emmett, ID on the Payette River. The dam is operated by the Bureau of Reclamation (BOR) and provides diverted irrigation water via the Black Canyon Canal and the Emmett Irrigation District Canal, as well as up to 10,000 kilowatts of electricity. BOR investigated the feasibility of installing an additional hydroelectric turbine to generate additional electricity. In winter 2012/2013, BOR drew the reservoir down for initial geologic studies and survey work, leaving only a minimum pool. At this low pool elevation, the reservoir became riverine and transported a large, though unquantified amount of sediment through the dam into the Payette River below. Large sediment deposits and dead fish were noted throughout the lower Payette River as a result. In July of 2013, Koenig et al. (2015) surveyed the lower Payette River to provide insight into the magnitude of the fish kill, which lead to a mitigation settlement between BOR and the Idaho Department of Fish and Game (IDFG).

In April of 2018, BOR decided not to pursue the installation of a third turbine at Black Canyon Dam. This provided IDFG with an opportunity to determine if the fish community was recovering from the fish kill in 2013. Therefore, in June/July 2018, the lower Payette River was surveyed to describe the composition, distribution, and relative abundance of the fish community and to describe trends in relative abundance between the standardized surveys conducted in 2009 (Butts et al. 2011), 2013 (Koenig et al. 2015), and 2018. In addition to the jet boat electrofishing survey completed to describe the trends through time, raft electrofishing was also used to determine the feasibility of switching gears for future trend surveys.

METHODS

The fish community was sampled in the lower Payette River between Black Canyon dam (rkm 62) and its confluence with the Snake River (rkm 0) twice during 2018. Twelve non-randomly selected study sites previously sampled in 2009 and 2013 were sampled within this reach. Sites contained readily identifiable landmarks, possessed diverse habitat types, and were well dispersed throughout the study area (Figure 58). These sites allowed relatively high catch rates of several species compared to simpler habitats, and will allow trend monitoring for a wide variety of fish species across time.

The first survey was completed in June using jet boat mounted electrofishing gear. A Midwest Lake Electrofishing System (MLES) Infinity system set at 25% duty cycle, 60 pulses per second, and approximately 2,200-2,800 watts of pulsed DC power generated by a 6,500-watt Honda generator was used. One netter positioned on the bow of the boat captured as many fish as possible, except Common Carp and Largescale Sucker. For these species, up to ten individuals were collected at each site and then counted the remainder without bringing them into the boat. At each site, one electrofishing pass was expended along or as near as possible to all riverbanks, including the banks of islands. Oxygen was introduced to the live well (2 L/min) through an air-stone. Electrofishing effort ranged from 0.19 to 0.52 h/site with a mean effort of 0.35 ± 0.05 h. Surveys were conducted during daylight hours from June 18 to 22, when water flows were similar to the previous surveys. During this period, mean daily river flow measured at the U.S. Geological Survey (USGS 2018) gauging station at Emmett, ID ranged from 65 to 92 m^3/s.

The second survey was completed in July using two 3.7 x 1.8 m Maravia® rafts each fitted with two pole-mounted anodes on the bow and cathodes hanging from both the starboard and port sides. Rafts carried the generator (3650 Watt Champion Power Equipment 100216), Midwest Lake Electrofishing Systems (MLES) Infinity electrofisher, and a live well for holding fish. One netter positioned on the bow of the boat, captured as many fish as possible, except Common Carp and Largescale Sucker. These species were treated similar to the survey described above. At each site, one electrofishing pass was expended along or as near as possible to one-river bank, utilizing separate rafts for each shoreline. Oxygen was introduced to the live well (2 L/min) through an air-stone. Pulsed direct current was used, while settings were 25% duty cycle, 60 pulses per second, and approximately 2,200-2,800 watts of power. Electrofishing effort ranged from 0.21 to 0.71 h/site with a mean effort of 0.40 ± 0.08 h. Surveys were conducted during daylight hours from July 16 to 19. During this period, mean daily river flow measured at the U.S. Geological Survey (USGS) gauging station at Emmett, ID ranged from 37 to 43 m^3/s.

Captured fish were identified to species, measured (± 1 mm), and weighed (±1 g for fish < 5,000 g or ± 10 g for fish > 5,000 g) with a digital scale. In the event that fish weight was not determined, length-weight relationships from fish sampled from the Payette River during 2018 were used to assign weights. Data were log transformed and linear regression was used to allow estimation of weight. PSD were calculated to describe length-frequency data for game fish populations as outlined by Anderson and Neuman (1996). In addition, Wr was calculated as an index of general fish body condition, for which a value of 100 is considered average. Values greater than 100 describe robust body condition, whereas values less than 100 indicate less than ideal foraging conditions. Electrofishing effort was converted to hours to standardize catch per unit effort (CPUE) and weight per unit effort in kg (WPUE) indices. Confidence intervals were calculated using $\alpha = 0.10$. All survey and individual fish data were stored in IDFG's standard stream survey database.

RESULTS

During 2018 lower Payette River jetboat sampling efforts, a total of 1,115 fish were sampled including 14 different species. Five species of game fish were sampled including Channel Catfish, Mountain Whitefish, Pumpkinseed *Lepomis gibbosus*, Rainbow Trout, and Smallmouth Bass. Eight native, non-game species were sampled including Bridgelip Sucker *Catostomus columbianus*, Chiselmouth *Acrocheilus alutaceus*, Largescale Sucker *C. macrocheilus*, Longnose Dace *Rhinichthys cataractae*, Northern Pikeminnow *Ptychocheilus oregonensis*, Redside Shiner *Richardsonius balteatus*, Sculpin *Cottus sp*., and Speckled Dace *R. osculus*. Finally, Common Carp was the only nonnative, non-game species sampled.

Total CPUE using jetboat electrofishing was 262 f/h (± 37f/h; 90% CI; Table 27). This was the second consecutive survey that total CPUE declined (374 f/h in 2009 and 348 f/h in 2013). The highest total CPUE was 393 f/h, observed at site LP07. The site was mainly comprised of Mountain Whitefish (60%), Largescale Sucker (29%), and Northern Pikeminnow (6%). CPUE tended to decrease at upstream sites (slope = -1.7; $r^2 = 0.53$; $p = 0.01$; Figure 59), and the lowest total CPUE of 155 f/h occurred 1.6 km downstream of Emmett, ID (site LP09). Mountain Whitefish was the most abundant species sampled and comprised 48% of the total CPUE, followed by Largescale Sucker (33%), Northern Pikeminnow (5%), Smallmouth Bass (4%), and Chiselmouth (3%), while all other species made up only 7%. Overall, 53% of the fish community was composed of game fish, whereas 47% was non-game fish.

The mean WPUE using jetboat electrofishing for all species combined was 136 kg/h (± 29; Table 28). The highest total WPUE was 221 kg/h for site LP04 just downstream from Blacks Bridge (rkm 20.0). Total WPUE was composed predominantly of Largescale Suckers (67%), Common Carp (24%), and Channel Catfish (7%). A directional trend of changing biomass was not apparent. The site with the lowest total WPUE of 65 kg/h was located directly below the highway 95 bridge in Fruitland, ID (site LP02). Largescale Sucker (63%) comprised the largest component of total WPUE, followed by Common Carp (18%), Northern Pikeminnow (6%), Channel Catfish (6%), and Mountain Whitefish (5%), while all other species made up only 2%. Overall, 12% of the WPUE or biomass was composed of game fish, whereas 88% was non-game fish.

Smallmouth Bass and Channel Catfish are the two main species targeted by anglers within the reach. For Smallmouth Bass, 40 individuals were sampled during the jetboat survey, with a mean length and weight of 200 mm (± 21) and 165 g (± 57), respectively (Figure 60). PSD equaled 23, calculated from 5 quality length (280 mm) fish and 22 stock length fish (180 mm). Relative weight, for the 31 Smallmouth Bass over 150 mm, averaged 100, indicating good body condition. CPUE averaged 9 f/h (± 4). For channel catfish, a total of 16 individuals were sampled, with a mean length and weight of 574 mm (± 32) and 1,914 g (± 289), respectively (Figure 60). PSD equaled 100, with all fish exceeding the 410 mm quality length criteria. Relative weight averaged 100, indicating good body condition. CPUE averaged 3.4 f/h (± 2).

During the raft survey efforts, a total of 597 fish were sampled. The sample of fish included 14 species, many of which were similar to the jetboat survey. The observed differences included sampling Flathead Catfish *Pylodictis olivaris*, Largemouth Bass *Micropterus salmoides*, and Yellow Perch *Perca flavescens*; however, no Pumpkinseed, Rainbow Trout, or Speckled Dace were sampled using the rafts. Mountain Whitefish and Largescale Suckers were the species found in greatest relative abundance using both survey gear types.

Total CPUE using raft electrofishing was significantly lower than the jetboat survey at 128 f/h (± 23; Table 29) when compared to jetboat electrofishing. The highest CPUE was 205 f/h, which was observed at site LP11. The site was comprised of Mountain Whitefish (51%), Largescale Sucker (31%), Sculpin (9%), Northern Pikeminnow (7%), and Channel Catfish (2%). Unlike the jetboat survey, no relationship was observed in directional change of total CPUE (slope = 0.3; $r^2 = 0.00$; $p = 0.93$); however, a relationship was observed for SMB, as relative abundance decreased moving upstream (slope = -4.3; $r^2 = 0.65$; $p = 0.00$). Overall, 55% of the fish community was composed of game fish, whereas 45% was non-game fish, which was very similar to the jetboat survey.

DISCUSSION

The jetboat survey completed in 2018 was the third survey using standardized sample sites and methodology (e.g. stream flows). Standardization between surveys enabled us to describe fish community changes after the sedimentation event. The decline in relative abundance identified between the 2009 and 2013 surveys lead to a mitigation settlement between BOR and IDFG. Three access sites have been renovated or developed within the reach using monies resulting from the mitigation settlement (see the Southwest Region's Fishing and Boating Access Program chapter in this report). Remaining funds should be used to secure additional access within the reach.

Smallmouth Bass and Channel Catfish populations have continued to decline in relative abundance since the sedimentation event. Other species, such as Mountain Whitefish and Largescale Suckers increased back to near 2009 levels of relative abundance (Butts et al. 2011; Figure 61). Changes in Smallmouth Bass abundance and distribution may be related to habitat changes associated with the extensive fine sediment deposited in the upper portion of the river as noted by Koenig et al. (2015). Declines may also be due to a series of major irrigation diversion dams causing seasonal migration barriers within the reach. One diversion dam, located near the upstream starting point of site LP05, was rebuilt in 2006. The new design may not allow fish to move upstream except in high flow events. Upstream of the newly designed diversion dam appears to be where CPUE dramatically decreased, for both species (Figure 59). Fish movement from the Snake River into the lower segment of this reach likely positively influence relative abundance and biomass indices. McClure (2018) used radio telemetry and showed how mobile Smallmouth Bass were within the lower Payette River. If these irrigation diversion dams are acting as seasonal migration barriers, natural recolonization of these species may take additional time. To facilitate natural recolonization of Smallmouth Bass, translocations, upstream of LP05, from neighboring populations should be completed. In addition, another standardized jetboat survey should be completed between three and five years after translocations have been completed.

CPUE differed between the most abundant species present in the surveys (e.g. Mountain Whitefish and Largescale Sucker) when comparing the two gear types (jetboat electrofishing vs. raft electrofishing); however, remained similar for species sampled less frequently. Mountain Whitefish and Largescale Suckers had significantly lower CPUE using the raft electrofishing gear when compared to the jetboat survey. However, species such as Channel Catfish, Common Carp, Northern Pikeminnow, and Smallmouth Bass had similar CPUE. Therefore, I believe for future comparisons of species composition and CPUE, jetboat electrofishing should be used if possible.

Entrainment of fishes prior to and since the drawdown are largely unknown. Koenig et al. (2015) hypothesized that increased catch rates of Largescale Sucker and Northern Pikeminnow may have been related to entrainment from the drawdown of Black Canyon Reservoir. Entrainment of species found in Black Canyon Reservoir is likely, however, a recent survey has not been completed. A recent survey would provide insight regarding relative abundance and likelihood of entrainment through Black Canyon Dam for the species present in the reservoir. The types and numbers of panfish species (e.g. Black Crappie or Yellow Perch) observed during the past three surveys is likely due to entrainment through the dam.

MANAGEMENT RECOMMENDATIONS

1. Continue to secure public access sites along the lower Payette River using funds derived from the mitigation settlement developed after the sedimentation event.
2. Increase abundance of Smallmouth Bass by translocating fish from nearby populations. Release Smallmouth Bass between Plaza Bridge and Seven Mile Slough access site to facilitate population recovery in the upstream portion of the reach.
3. Repeat a standardized jetboat electrofishing survey between 2021 and 2023 to determine if translocating Smallmouth Bass facilitated population recovery with the reach.
4. Complete a standardized lowland lake survey in Black Canyon Reservoir to identify fish community changes upstream of Black Canyon Dam. This survey would provide additional insight into relative abundance of species that could be entrained into the lower Payette River.

Table 27. Electrofishing catch per unit effort indices (f/h) for 12 sites surveyed on the Lower Payette River during 2018 using jetboat electrofishing. Species names were abbreviated as Bridgelip Sucker (BLS), Channel Catfish (CAT), Chiselmouth (CSL), Common Carp (CRP), Largescale Sucker (LSS), Longnose Dace (LND), Mountain Whitefish (MWF), Northern Pikeminnow (NPM), Pumpkinseed (PKS), Rainbow Trout (RBT), Redside Shiner (RSS), Sculpin *Cottus sp.* (SCP), Smallmouth Bass (SMB), and Speckled Dace (SPD).

River km	Site	Effort (h)	BLS	CAT	CSM	CRP	LSS	LND	MWF	NPM	PKS	RBT	RSS	SCP	SMB	SPD
3.4	LP1	0.24	8.2	8.2	8.2	4.1	123.4	0.0	49.4	0.0	4.1	0.0	0.0	0.0	24.7	0.0
6.1	LP2	0.50	9.9	7.9	11.9	6.0	101.3	0.0	83.4	4.0	0.0	2.0	0.0	0.0	11.9	0.0
13.5	LP3	0.52	3.9	5.8	11.7	5.8	110.7	0.0	182.5	9.7	0.0	0.0	1.9	1.9	13.6	0.0
20	LP4	0.31	3.2	6.5	3.2	16.2	135.7	0.0	16.2	9.7	0.0	0.0	0.0	0.0	9.7	3.2
26.4	LP5	0.40	7.5	10.0	10.0	10.0	92.1	2.5	44.8	5.0	0.0	0.0	0.0	0.0	17.4	0.0
34.4	LP6	0.37	0.0	0.0	0.0	8.2	16.4	0.0	219.2	2.7	0.0	0.0	0.0	16.4	11.0	2.7
38.9	LP7	0.35	0.0	0.0	14.2	0.0	113.9	2.8	236.4	22.8	0.0	0.0	0.0	2.8	0.0	0.0
43.1	LP8	0.34	2.9	2.9	26.5	8.8	88.3	0.0	194.3	26.5	0.0	0.0	0.0	0.0	2.9	0.0
52	LP9	0.37	0.0	0.0	0.0	0.0	57.1	0.0	62.6	27.2	0.0	0.0	0.0	2.7	0.0	5.4
55.8	LP10	0.41	4.9	0.0	4.9	12.2	31.6	0.0	155.6	24.3	0.0	0.0	0.0	12.2	14.6	12.2
58.1	LP11	0.19	5.3	0.0	0.0	0.0	89.6	0.0	116.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0
60.7	LP12	0.19	5.3	0.0	0.0	0.0	121.9	0.0	111.3	5.3	0.0	0.0	0.0	5.3	0.0	0.0
		Average by *Spp*.	4.3	3.4	7.5	5.9	90.2	0.4	122.6	12.3	0.3	0.2	0.2	3.5	8.8	2.0
		Total CPUE	4.3	3.8	8.4	6.5	87.7	0.5	126.6	12.7	0.2	0.2	0.2	3.6	9.6	2.2

Table 28. Electrofishing weight per unit effort indices (kg/h) for 12 sites surveyed on the Lower Payette River during 2018, using jetboat electrofishing. Species names were abbreviated as Bridgelip Sucker (BLS), Channel Catfish (CAT), Chiselmouth (CSL), Common Carp (CRP), Largescale Sucker (LSS), Longnose Dace (LND), Mountain Whitefish (MWF), Northern Pikeminnow (NPM), Pumpkinseed (PKS), Rainbow Trout (RBT), Redside Shiner (RSS), Sculpin *Cottus sp.* (SCP), Smallmouth Bass (SMB), and Speckled Dace (SPD). Dashed lines indicated missing values where the species was not collected.

River km	Site	Effort (h)	BLS	CAT	CSM	CRP	LSS	LND	MWF	NPM	PKS	RBT	RSS	SCP	SMB	SPD
3.4	LP1	0.24	1.3	19.2	0.8	15.2	94.6	-	0.1	0.0	0.0	-	-	-	1.1	-
6.1	LP2	0.50	2.4	13.9	0.7	19.9	24.2	-	0.2	0.3	-	0.3	-	-	2.8	-
13.5	LP3	0.52	0.5	9.7	1.8	18.0	90.0	-	2.5	3.0	-	-	0.0	0.0	3.0	-
20	LP4	0.31	0.4	15.4	0.4	53.8	148.2	-	0.0	1.4	-	-	-	-	1.2	0.0
26.4	LP5	0.40	0.8	16.6	0.4	31.9	129.8	0.0	3.7	2.9	-	-	-	-	3.0	-
34.4	LP6	0.37	-	0.0	-	41.8	20.4	-	2.0	2.9	-	-	-	0.1	2.3	0.0
38.9	LP7	0.35	-	0.0	1.5	0.0	99.7	0.1	8.5	25.7	-	-	-	0.0	0.0	-
43.1	LP8	0.34	0.1	0.0	1.3	40.2	36.8	-	4.7	8.9	-	-	-	-	0.3	-
52	LP9	0.37	-	0.0	-	0.0	93.8	-	3.5	24.8	-	-	-	0.0	0.0	0.0
55.8	LP10	0.41	0.1	0.0	0.5	29.7	29.9	-	5.1	9.1	-	-	-	0.1	2.1	0.0
58.1	LP11	0.19	0.7	0.0	-	0.0	151.8	-	28.3	8.3	-	-	-	-	0.0	-
60.7	LP12	0.19	5.9	0.0	-	0.0	152.3	-	53.8	1.1	-	-	-	0.0	0.0	-
Average by *Spp.*			1.3	6.2	0.9	20.9	89.3	0.1	9.4	7.4	0.0	0.3	0.0	0.0	1.3	0.0
Total WPUE			0.8	7.3	0.7	22.4	80.9	0.0	6.5	7.4	0.0	0.0	0.0	0.0	1.6	0.0

Table 29. Electrofishing catch per unit effort indices (f/h) for 12 sites surveyed on the Lower Payette River during 2018 using raft electrofishing. Species names were abbreviated as Bridgelip Sucker (BLS), Channel Catfish (CAT), Chiselmouth (CSL), Common Carp (CRP), Flathead Catfish (FAT), Largescale Sucker (LSS), Largemouth Bass (LMB), Longnose Dace (LND), Mountain Whitefish (MWF), Northern Pikeminnow (NPM), Redside Shiner (RSS), Sculpin *Cottus sp.* (SCP), Smallmouth Bass (SMB), and Yellow Perch (YLP).

River km	Site	Effort (hr)	BLS	CAT	CSM	CRP	FAT	LSS	LMB	LND	MWF	NPM	RSS	SCP	SMB	YLP
3.4	LP1	0.34	5.9	0.0	5.9	5.9	3.0	14.8	0.0	0.0	109.3	0.0	0.0	0.0	56.1	0.0
6.1	LP2	0.71	9.9	5.6	9.9	9.9	0.0	38.1	1.4	0.0	16.9	2.8	0.0	1.4	48.0	0.0
13.5	LP3	0.41	4.9	17.3	0.0	9.9	0.0	17.3	0.0	0.0	19.7	7.4	0.0	2.5	29.6	0.0
20	LP4	0.41	4.9	26.8	4.9	7.3	0.0	29.2	0.0	0.0	2.4	31.7	0.0	0.0	9.7	0.0
26.4	LP5	0.67	0.0	3.0	13.5	6.0	0.0	6.0	1.5	0.0	15.0	33.0	0.0	0.0	15.0	1.5
34.4	LP6	0.21	0.0	0.0	0.0	14.5	0.0	19.3	0.0	0.0	67.6	4.8	0.0	0.0	0.0	0.0
38.9	LP7	0.48	2.1	4.2	12.5	2.1	0.0	10.4	0.0	0.0	22.8	14.5	0.0	0.0	6.2	0.0
43.1	LP8	0.35	2.8	2.8	2.8	22.6	0.0	0.0	0.0	2.8	45.1	14.1	0.0	2.8	11.3	2.8
52	LP9	0.30	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	50.4	6.7	3.4	3.4	0.0	0.0
55.8	LP10	0.39	0.0	0.0	0.0	2.6	0.0	23.0	0.0	5.1	112.4	17.9	0.0	7.7	2.6	0.0
58.1	LP11	0.22	0.0	4.6	0.0	0.0	0.0	63.8	0.0	0.0	104.8	13.7	0.0	18.2	0.0	0.0
60.7	LP12	0.30	0.0	0.0	0.0	13.2	0.0	56.3	0.0	0.0	49.7	6.6	0.0	6.6	6.6	0.0
		Average by *Spp*.	2.5	5.4	4.1	7.8	0.2	23.7	0.2	0.7	51.4	12.8	0.3	3.5	15.4	0.4
		Total CPUE	3.1	5.9	5.6	7.7	0.2	22.2	0.4	0.6	43.1	14.0	0.2	2.7	18.6	0.4

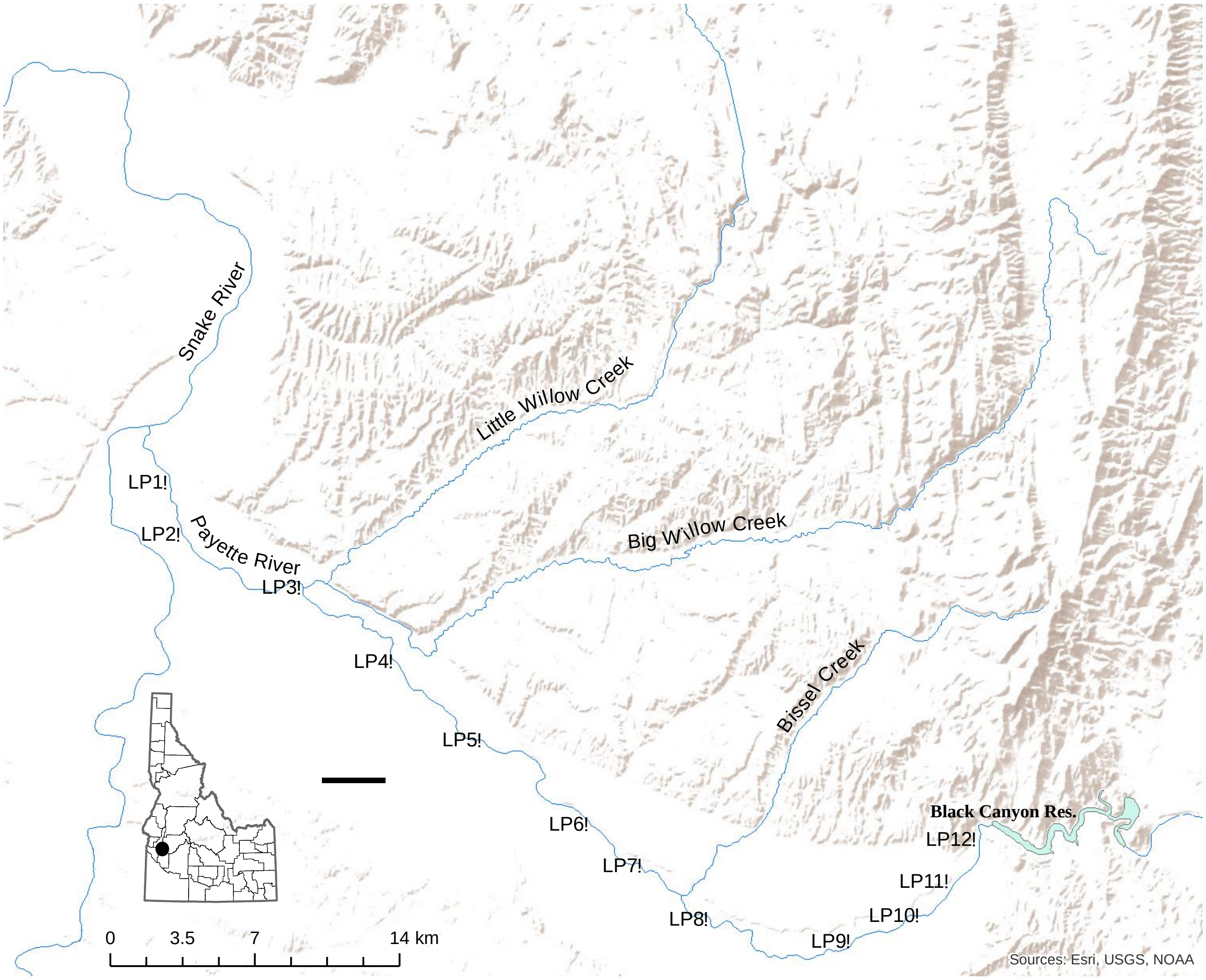


Figure 58. Electrofishing trend survey sites on the lower Payette River between Black Canyon Dam and the Snake River surveyed in 2009, 2013, and 2018.

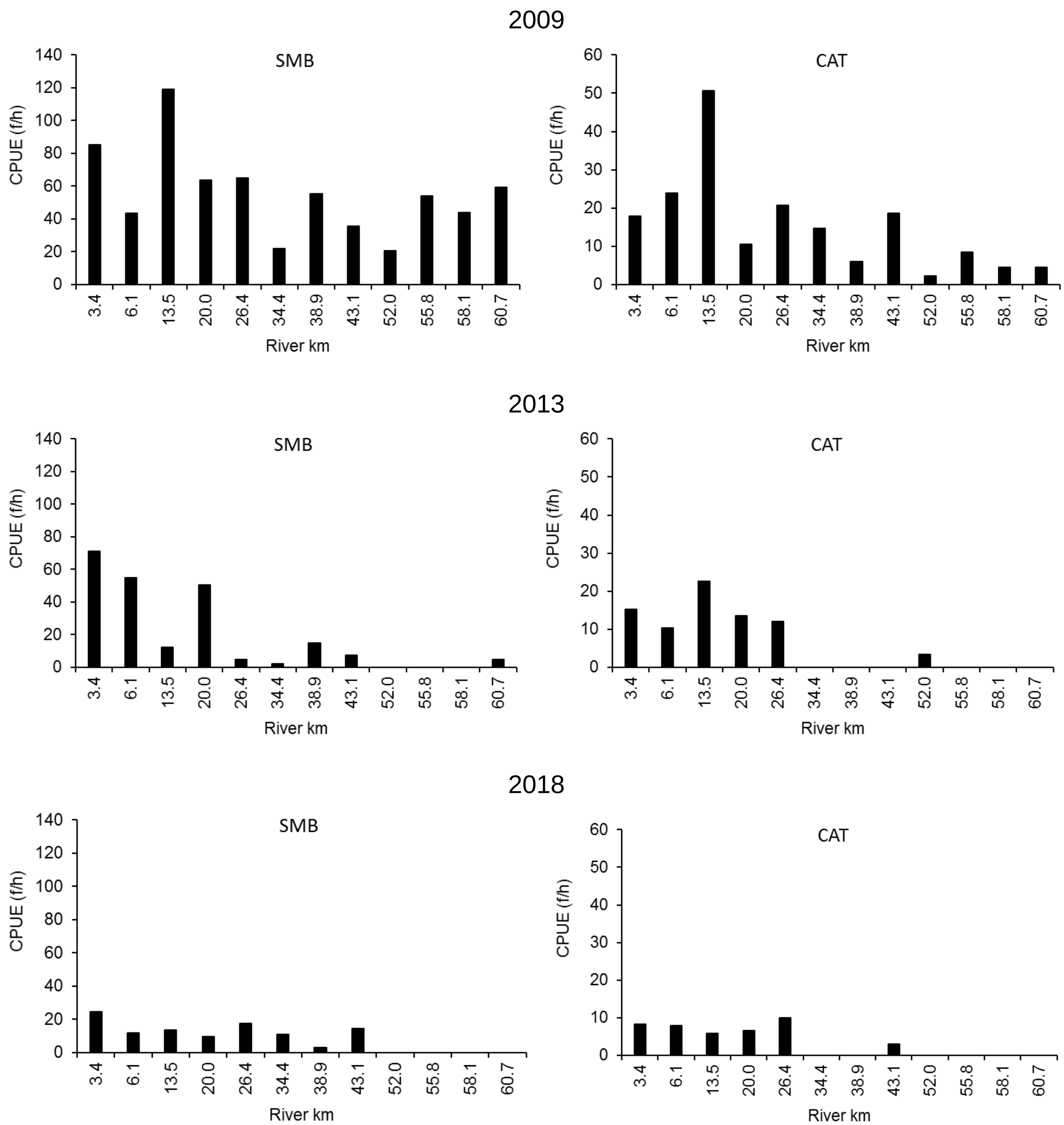
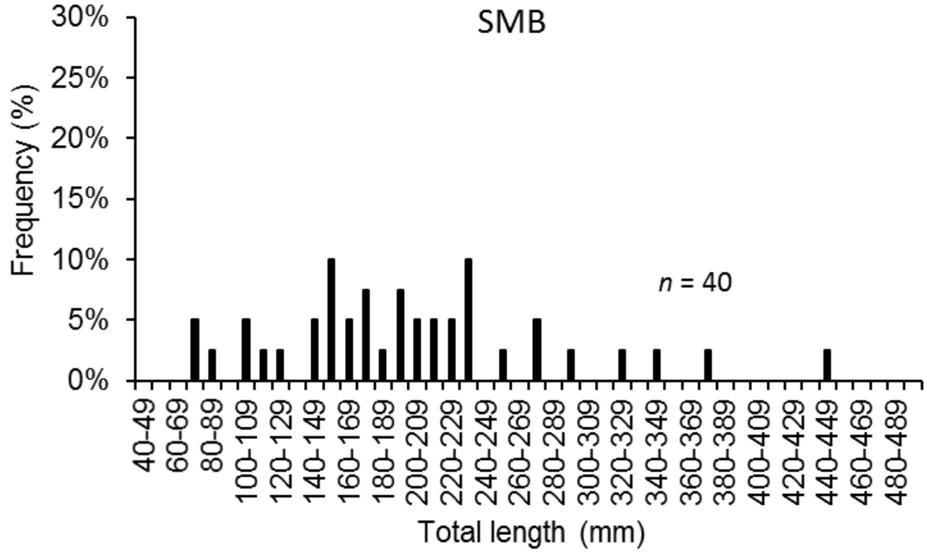


Figure 59. Catch per unit effort (CPUE; f/h) for Smallmouth Bass (SMB) and Channel Catfish (CAT) during the past three lower Payette River surveys by river kilometer. The confluence with the Snake River is denoted by river kilometer zero.



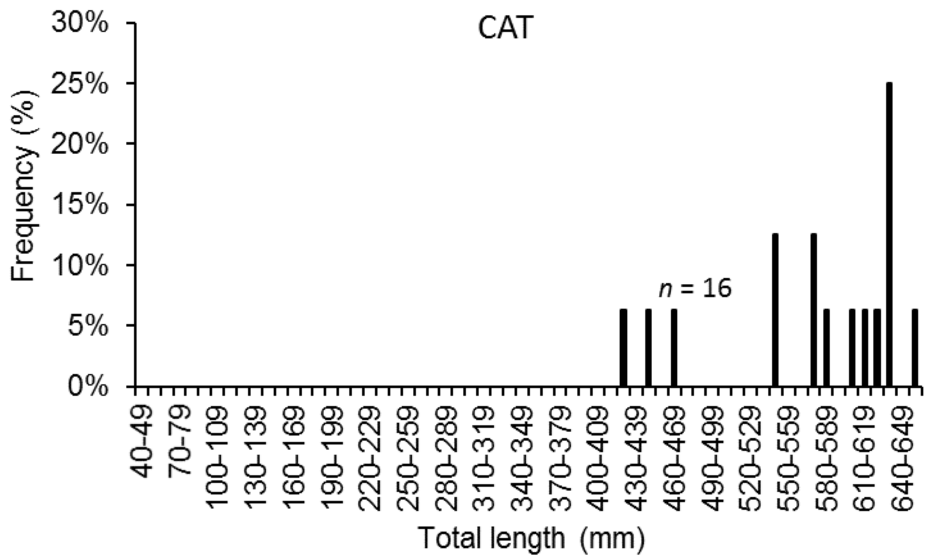


Figure 60. Length-frequency distribution of Smallmouth Bass (SMB) and Channel Catfish (CAT) sampled during the 2018 lower Payette River survey using the jetboat, all sites combined.

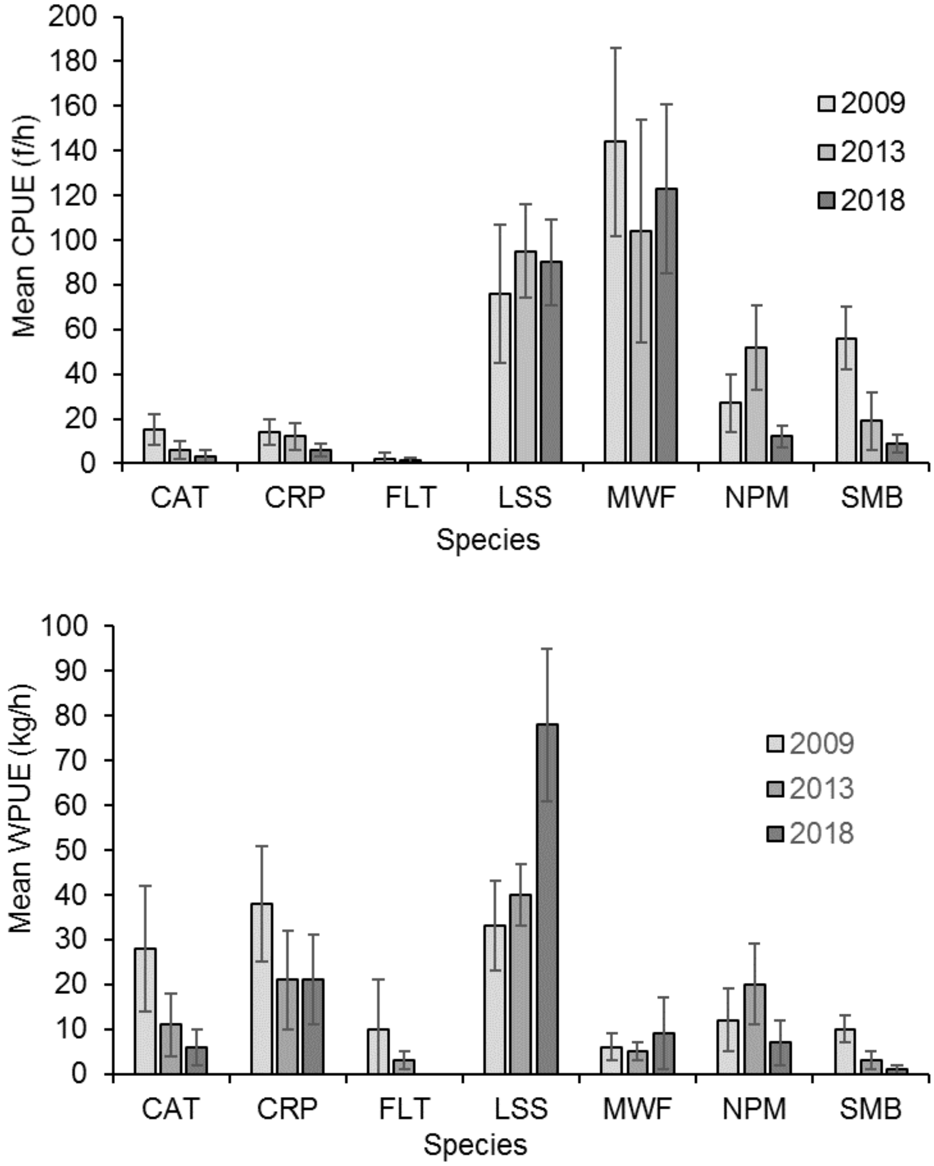


Figure 61. Mean catch per unit effort (CPUE; f/h) and weight per unit effort (WPUE; kg/h) for Channel Catfish (CAT), Common Carp (CRP), Flathead Catfish (FLT), Largescale Sucker (LSS), Mountain Whitefish (MWF), Northern Pikeminnow (NPM), and Smallmouth Bass (SMB) sampled in the lower Payette River for each of the past three trend surveys. Error bars indicate 90% confidence intervals.

FISHING AND BOATING ACCESS PROGRAM SUMMARY

ABSTRACT

Southwest Region staff maintain 48 fishing and boating access sites within southwest Idaho. Sites need continual maintenance, repair, and cleaning. These responsibilities were completed as usual. In addition, staff facilitated the initiation or completion of several improvement projects at IDFG-owned properties including Caldwell Ponds, Horseshoe Bend Mill Pond, Map Rock, and Roberts. Furthermore, staff initiated or completed three new access acquisitions including Bent Lane, an unnamed site on the Lower Boise River, and Sawyers II. Lastly, staff spent considerable time developing or improving partnerships to cooperatively manage camping at Horsethief Reservoir with the YMCA and other partners, improve access to the lower Payette River with the Gem County, re-new a memorandum-of-understanding with Boise County for maintenance of amenities at Horseshoe Bend Mill Pond, and assist with maintenance and manage camping at Martin Landing.

Author(s):

Joe Kozfkay
Regional Fishery Manager

Dennis Hardy
Recreation Site Maintenance Foreman

INTRODUCTION

The goal of Idaho Department of Fish and Game's Fishing and Boating Access program is to provide high-quality developed access sites and amenities that allow hunters, anglers, and trappers to safely recreate on a wide variety of waters throughout southwest Idaho. Staff maintains 48 fishing and boating access sites within IDFG's Southwest Region boundaries, including the McCall sub-region. Within this large geographical area, a total of 27 developed access sites are located on properties owned by IDFG, while the remaining 21 developed access sites provide opportunities on and from non-department owned properties. Additionally, access to properties owned by other agencies (state, federal, or non-governmental organizations) is provided with cooperative agreements, memorandums-of-understanding, or right-of-ways. Access site facilities and properties require a high amount of maintenance. Maintenance activities and frequencies are adjusted to account for use, weather, vandalism, and other reasons on an as-needed basis. Typical maintenance activities include: cleaning and pumping vault toilets, inspecting and maintaining dams and water control infrastructure, grading roads and parking areas, managing cleaning contractors, removing, repairing, and installing docks, removing sediment from boat ramps, managing vegetation, maintaining border fences, as well as posting and replacing worn or damaged signs.

In addition to normal maintenance responsibilities and activities, regional staff participate in capital improvement projects that often involve constructing new access amenities at new or existing sites or replacing dilapidated infrastructure at existing sites. Furthermore, staff encourages and facilitates the development of fishing and boating access sites and opportunities on properties owned by others such as city or county governments. Funding for this program originates from a variety of sources including the Dingell-Johnson and Pittman-Robertson excise taxes (administered by the U.S. Fish and Wildlife Service), license money (generated from the sales of IDFG licenses, tags, and permits; mitigation settlements), as well as a variety of grant sources.

ACCOMPLISHMENTS

In 2018, Southwest Region staff continued to provide normal operations and maintenance activities across fishing/boat access sites. In addition, staff contributed directly to the completion of several larger-scale renovation or repair projects on department-managed properties during 2018. Staff initiated discussions with a gravel excavation company to enlarge the size and volume of ponds at Caldwell Ponds. Eventual project completion will substantially increase pond size and depth, thereby providing better fishing opportunity. At Horseshoe Bend Mill Pond, staff worked closely with an adjacent private property owner to plan a project to stabilize an eroding bank. Though the project's location is on IDFG-owned property, the objective is to prevent private property loss downstream. An agreement was reached and tentative plans for construction during 2019 are being considered. A large-scale renovation and improvement project was completed at Map Rock, located adjacent to the Snake River in southern Canyon County. This project included replacing a dilapidated boat ramp, developing new parking areas and a restroom, and installing fences, boulders, and parking bumpers to properly manage motorized use and reduce resource damage. Site improvements cost approximately $112,500. Lastly, an additional dilapidated boat ramp was removed and replaced at the Roberts Access. Here, Snake River currents had undermined the existing ramp causing slumping and separation of concrete sections, making it unsafe and unstable. Ramp replacement costs approximated $45,000.

Staff spend considerable time working towards acquiring or securing rights to new parcels for eventual development into access sites. Staff negotiated, developed, and recorded (in Canyon

County) a three-party agreement (2018-029674) to provide access across private property to the Boise River and adjacent state lands. The easement was donated by the developer, Tim Eck of E4 Partners, LLP. The easement allows vehicle travel from the end of a city road (Trinity Creek Lane) in the Star River Ranch Subdivision to a yet-to-be developed 10,000 ft^2 parking area adjacent to the Boise River, and for foot travel along the river bank to state lands adjacent to the river. The easement agreement also designates that the City of Star desires to contribute to improvement, management, and maintenance. Full public access will be allowed shortly after gravel mining operations are completed. Also, staff worked towards accepting a donation of 68-acre parcel near Emmett, Idaho. The proposed donation has progressed through the lands committee and commission process. However, the deed will not be transferred until gravel mining operations are completed. Lastly, staff recently initiated the process for accepting donation of an 11-acre parcel on the lower Boise River.

Staff has sought partnerships to increase efficiency, provide better service, and improve management of several access sites. Currently, the most active partnership is with the Treasure Valley YMCA (TVYMCA) at Horsethief Reservoir. TVYMCA completed their first full year of camping-fee collection during 2018. IDFG sought and secured Idaho Department of Parks and Recreation RV grants and completed two projects here during 2018. The first are larger project resulted in development of host site amenities including, electrical, water, and sewer hook ups. Project costs approximated $153,000, with $128,000 originating from the RV fund. The second project resulted in the purchase and placement of picnic tables and fire rings at many of the campsites. Project cost approximated $67,000 with $41,000 originating from the RV fund. Furthermore, staff were awarded an additional large grant ($733,000) for improving the Kings Point camping area. This project will be completed during 2019. Martin Landing is also managed with a cooperative partnership with Canyon County. A host is stationed at Martin Landing to oversee the site and camping areas, as well as to prevent resource damage. During 2018, users of over-night camping sites were required to pay a fee. Fees were collected by campground hosts and funds were held and managed by Southwest Idaho Resource Conservation and Development. Funds are re-invested in management of the camping area. Staff initiated site improvement at three sites near Emmett, ID as part of the Gem County Partnership. The Plaza, Emmett Segment, and newly-secured Sheep Camp Landing site (near Letha Bridge) were enhanced by improving parking areas, adding temporary restroom kiosks and signs. Installing fences, boulders, and gates was intended to help deter off-road vehicle use. Lastly, in the past, staff have partnered with Idaho Power Company (IPC) to provide access to the Snake River near Weiser at the Olds Ferry site. This site had become degraded and is in need of repair. IPC has committed to improve the site in the near future with little contribution from IDFG.

Other noteworthy accomplishments included work to ensure that department-owned dams were being maintained to Idaho Department of Water Resources standards.

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Appendix A. GPS coordinates for the spring, fall, and otter trawl surveys conducted on CJ Strike Reservoir in 2017 (WGS 84; latitude and longitude are presented in decimal degrees).

Spring Relative Abundance Survey											
Strata	Lat	Long	Name	Strata	Lat	Long	Name	Strata	Lat	Long	Name
Snake River Arm	42.97255	-115.79919	SST1	Main Pool	42.97313	-115.97469	SMT1	Bruneau River Arm	42.92212	-115.86923	SBT1
Snake River Arm	42.97445	-115.80513	SST2	Main Pool	42.96868	-115.97828	SMT2	Bruneau River Arm	42.92310	-115.88089	SBT2
Snake River Arm	42.97194	-115.81567	SST3	Main Pool	42.96349	-115.97148	SMT3	Bruneau River Arm	42.93901	-115.94287	SBT3
Snake River Arm	42.97134	-115.84682	SST4	Main Pool	42.95803	-115.96708	SMT4	Bruneau River Arm	42.91374	-115.89457	SBT4
Snake River Arm	42.93819	-115.94981	SST5	Main Pool	42.93819	-115.94981	SMT5	Bruneau River Arm	42.93623	-115.92909	SBT5
Snake River Arm	42.98385	-115.86594	SST6	Main Pool	42.94595	-115.94585	SMT6	Bruneau River Arm	42.91204	-115.88791	SBT6
Snake River Arm	42.97917	-115.90572	SST7	Main Pool	42.95471	-115.95115	SMT7	Bruneau River Arm	42.91110	-115.88245	SBT7
Snake River Arm	42.96893	-115.83859	SSG1	Main Pool	42.98811	-115.96645	SMG1	Bruneau River Arm	42.91279	-115.85597	SBG1
Snake River Arm	42.98903	-115.87522	SSG2	Main Pool	42.98191	-115.96972	SMG2	Bruneau River Arm	42.91962	-115.86393	SBG2
Snake River Arm	42.98426	-115.92045	SSG3	Main Pool	42.96382	-115.96100	SMG3	Bruneau River Arm	42.90962	-115.85506	SBG3
Snake River Arm	43.00125	-115.93066	SSG4	Main Pool	42.95862	-115.95634	SMG4	Bruneau River Arm	42.92112	-115.89888	SBG4
Snake River Arm	42.98642	-115.87957	SSE1	Main Pool	42.96731	-115.95781	SME1	Bruneau River Arm	42.90431	-115.84604	SBE1
Snake River Arm	42.97114	-115.83425	SSE2	Main Pool	42.97356	-115.96573	SME2	Bruneau River Arm	42.92151	-115.87623	SBE2
Snake River Arm	42.97479	-115.80807	SSE3	Main Pool	42.98699	-115.95655	SME3	Bruneau River Arm	42.90678	-115.87946	SBE3
Snake River Arm	42.99023	-115.88002	SSE4	Main Pool	42.99554	-115.95143	SME4	Bruneau River Arm	42.92528	-115.88662	SBE4
Snake River Arm	42.98941	-115.88525	SSE5	Main Pool	42.98456	-115.96807	SME5	Bruneau River Arm	42.91629	-115.89926	SBE5
Snake River Arm	42.99258	-115.91540	SSE6	Main Pool	42.97916	-115.97148	SME6	Bruneau River Arm	42.93383	-115.92124	SBE6
Fall Relative Abundance Survey											
Strata	Lat	Long	Name	Strata	Lat	Long	Name	Strata	Lat	Long	Name
Snake River Arm	42.971599	-115.822315	FSE1	Main Pool	42.987879	-115.967025	FME1	Bruneau River Arm	42.937157	-115.931582	FBE1
Snake River Arm	42.969113	-115.849939	FSE2	Main Pool	42.975748	-115.965840	FME2	Bruneau River Arm	42.911997	-115.888670	FBE2
Snake River Arm	42.977122	-115.909399	FSE3	Main Pool	42.986289	-115.956635	FME3	Bruneau River Arm	42.929854	-115.915437	FBE3
Snake River Arm	42.986620	-115.910691	FSG1	Main Pool	42.962899	-115.970712	FMG1	Bruneau River Arm	42.941260	-115.937782	FBG1
Snake River Arm	42.996382	-115.948126	FSG2	Main Pool	42.953126	-115.949837	FMG2	Bruneau River Arm	42.918798	-115.861282	FBG2
Snake River Arm	42.987119	-115.890420	FST1	Main Pool	42.996167	-115.953534	FMT1	Bruneau River Arm	42.937880	-115.935880	FBT1
Snake River Arm	42.980289	-115.918527	FST2	Main Pool	42.995655	-115.957439	FMT2	Bruneau River Arm	42.902842	-115.874960	FBT2
Snake River Arm	43.003464	-115.928693	FST3	Main Pool	42.956278	-115.967026	FMT3	Bruneau River Arm	42.922148	-115.869068	FBT3
Snake River Arm	42.995886	-115.938103	FST4	Main Pool	42.981571	-115.959714	FMT4	Bruneau River Arm	42.921312	-115.902116	FBT4
Otter Trawl Relative Abundance Survey											
Strata	Lat	Long	Name	Strata	Lat	Long	Name	Strata	Lat	Long	Name
Snake River Arm	42.990630	-115.918470	CJ1	Main Pool	42.963940	-115.961240	CJ5	Bruneau River Arm	42.921170	-115.900482	CJ9
Snake River Arm	42.993690	-115.939860	CJ2	Main Pool	42.960610	-115.957940	CJ6	Bruneau River Arm	42.919300	-115.879900	CJ10
Snake River Arm	42.979820	-115.910194	CJ3	Main Pool	42.946610	-115.946510	CJ7	Bruneau River Arm	42.915350	-115.882260	CJ11
Snake River Arm	42.969954	-115.836440	CJ4	Main Pool	42.938950	-115.951210	CJ8	Bruneau River Arm	42.916050	-115.857530	CJ12

Prepared by:

Michael P. Peterson
Regional Fishery Biologist

John D. Cassinelli
Regional Fishery Manager

Dennis Hardy
Recreation Site Foreman

Approved by:
IDAHO DEPARTMENT OF FISH AND GAME

Joseph R. Kozfkay
State Fishery Manager

James P. Fredericks
Chief of Fisheries